BYTE®

the small systems journal

FEBRUARY 1981 Vol. 6, No. 2
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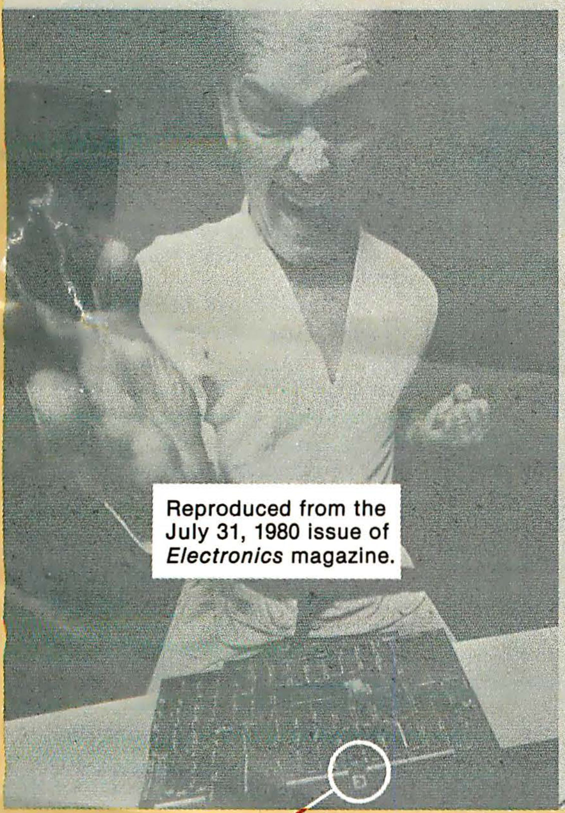
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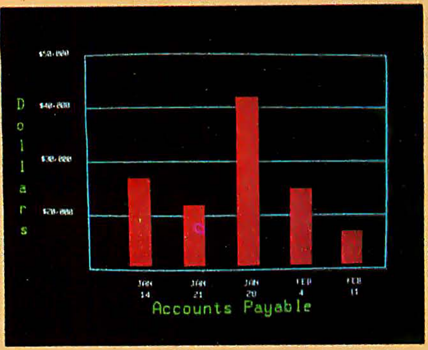
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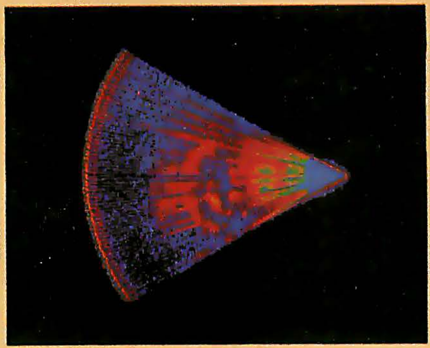
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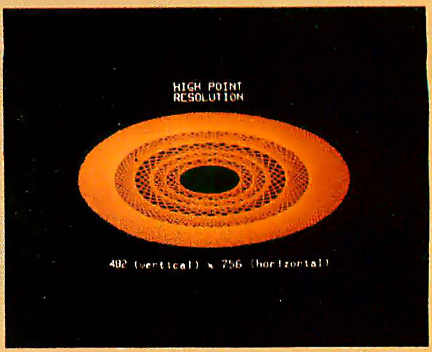
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Get the professional color display that has BASIC/FORTRAN simplicity

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When we say the SDI results in a high-quality professional display, we mean **you can't get higher resolution than this system offers in an** NTSC-conforming display.

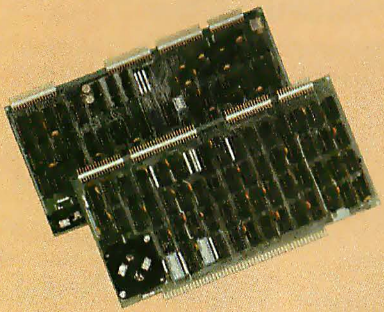
The resolution surpasses that of a color TV picture.

BASIC/FORTRAN programming

Besides its high resolution and low price, the new SDI lets you control with optional Cromemco software packages that use simple BASIC- and FORTRAN-like commands.

Pick any of 16 colors (from a 4096-color palette) with instructions like DEFCLR (c, R, G, B). Or obtain a circle of specified size, location, and color with XCIRC (x, y, r, c).

*U.S. Pat. No. 4121283



Model SDI High-Resolution Color Graphics Interface

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The SDI's high resolution gives a professional-quality display that strictly meets NTSC requirements. You get 756 pixels on every visible line of the NTSC standard display of 482 image lines. Vertical line spacing is 1 pixel.

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The SDI has still more features that you should be informed about. So contact your Cromemco representative now and see all that the SDI will do for you.

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Volume 6, Number 2

February 1981

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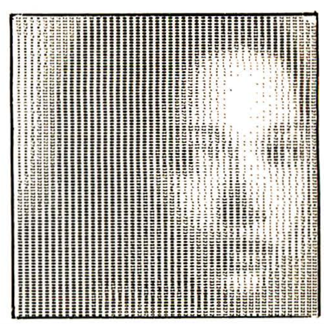
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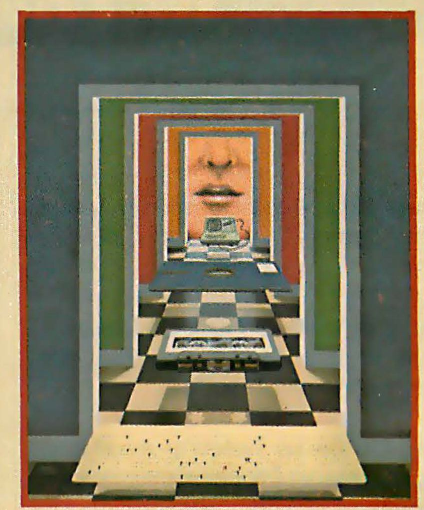
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In This Issue

This month we talk about voices — computer voices, that is — and several other topics as well.

Consulting Editor Mark Dahmke speaks out on speech in the editorial "Computer Speech: An Update." We also have two theme articles: "An Extremely Low-Cost Computer Voice Response System," which shows how to computerize your vox humana for very little money, and "Articulate Automata," which looks at the physiology of speech.

Also in this issue is Steve Ciarcia's do-it-yourself computerized Big Trak; everything you've always wanted to know about dynamic memory; inexpensive A/D and D/A conversion; and much more, including reviews of the new Radio Shack Daisy Wheel Printer II, the Heath H-14 printer, not to mention Zork and IRV.

BYTE is published monthly by BYTE Publications Inc, 70 Main St, Peterborough NH 03458, a wholly-owned subsidiary of McGraw-Hill, Inc. Address all mail except subscriptions to above address: phone (603) 924-9281. Address subscriptions, change of address, USPS Form 3579, and fulfillment questions to BYTE Subscriptions, POB 590, Martinsville NJ 08836. Controlled circulation postage paid at Waseca, Minnesota 56093 - USPS Publication No. 528890 (ISSN 0360-5281). Canadian second class registration number 9321. Subscriptions are $19 for one year, $34 for two years, and $49 for three years in the USA and its possessions. In Canada and Mexico, $21 for one year, $38 for two years, $55 for three years. $43 for one year air delivery to Europe. $35 surface delivery elsewhere. Air delivery to selected areas at additional rates upon request. Single copy price is $2.50 in the USA and its possessions, $2.95 in Canada and Mexico, $4.00 in Europe, and $4.50 elsewhere. Foreign subscriptions and sales should be remitted in United States funds drawn on a US bank. Printed in United States of America.

Address all editorial correspondence to the editor at BYTE, POB 372, Hancock NH 03449. Unacceptable manuscripts will be returned if accompanied by sufficient first class postage. Not responsible for lost manuscripts or photos. Opinions expressed by the authors are not necessarily those of BYTE.

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Editorial

Computer Speech: An Update

Guest Editorial by Mark C Dahmke

In 1972 I saw an advertisement in *Scientific American* for the Votrax speech synthesizer — a multiple-board system that produced fairly intelligible speech. Although digital speech synthesis has been with us for more than a generation, it wasn't until the early seventies that relatively low cost, compact synthesizers were available for use in industry. At the time, I became very interested in the concept and wanted to experiment with a synthesizer, but the price was still too high for my budget.

Finally, in August 1976, BYTE published an issue on speech synthesis. The article "Friends, Humans, Countryrobots: Lend me your Ears" described in detail the Computalker CT-1 speech synthesizer designed by Computalker



Photo 1: *The author of this month's guest editorial, Mark Dahmke (left), demonstrating the special speech-generating computer system, "The Bionic Voice," he developed for his friend Bill Rush. The Computalker-based system allows Bill, a quadriplegic, to "speak" with the aid of a head stick. Mark and Bill were the subjects of a feature story in* Life *magazine last year that was later condensed in the* Reader's Digest. *Hollywood is interested, too: a movie is being produced for television that will tell their story and show how personal computers can make a profound difference in people's lives. Mark is a Consulting Editor for BYTE, and has had a continuing interest in computer speech for many years. His forthcoming book,* Microcomputer Operating Systems, *will be published by BYTE Books later this year....* **CM** *(Photo courtesy Brian Lanker).*

Consultants of Santa Monica, California. The CT-1 was an S-100 board, consisting of a formant-based synthesizer, driven by nine parallel output ports. The data rate required was only 100 bytes per control parameter per second, or 800 bytes per second for normal speech.

Several software packages were provided: the CTMON program and later CTEDIT, allowing the user to enter and edit parameter data. Another package called CSR1, the Computalker Synthesis by Rule Program, accepted as input a character string of phonemes from the International Phonetic Alphabet and generated fairly good speech. During the mid-1970s, several other single-board speech synthesizers became available, allowing hobbyists and researchers to experiment with state-of-the-art hardware and software without going into debt.

It was not until early in 1979 that I obtained a Computalker board for experimentation. The project was to design a "Bionic Voice" for my friend Bill Rush, a student at the University of Nebraska who has cerebral palsy. (See my article, "A Voice for Bill," in the Winter 1979 issue of *onComputing*.) I used the CSR1 package and wrote a dictionary handler program to make the system easy to use (since Bill does not have full control of his limbs, he types hunt-and-peck style using a stick attached to a band around his forehead).

More recently, I attended a VOCA (Voice Output Communication Aid) Conference in Berkeley, California, in May 1980. It is obvious from such conferences and discussions that voice output for the nonvocal and nonverbal (and talking terminals for the blind) are high on the list of potential applications of voice input/output technology.

On the consumer electronics front, VIO (voice input/output) technology seems to be the trend setter of the eighties. This becomes immediately apparent when one walks through a consumer electronics show, the West Coast Computer Faire, or numerous other product shows. Instead of just flashing lights and color video displays, products are now talking at, about, and with you.

Some recent developments in speech synthesis include the Votrax SC01 single-chip formant synthesizer mentioned in "Articulate Automata" in this issue. Texas Instruments has been at the forefront of the LPC (linear predictive coding) approach. One of its most successful products, Speak & Spell, shows what can be done in the consumer products market.

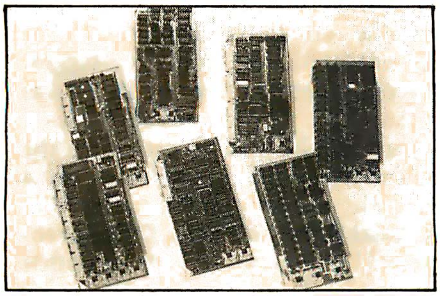
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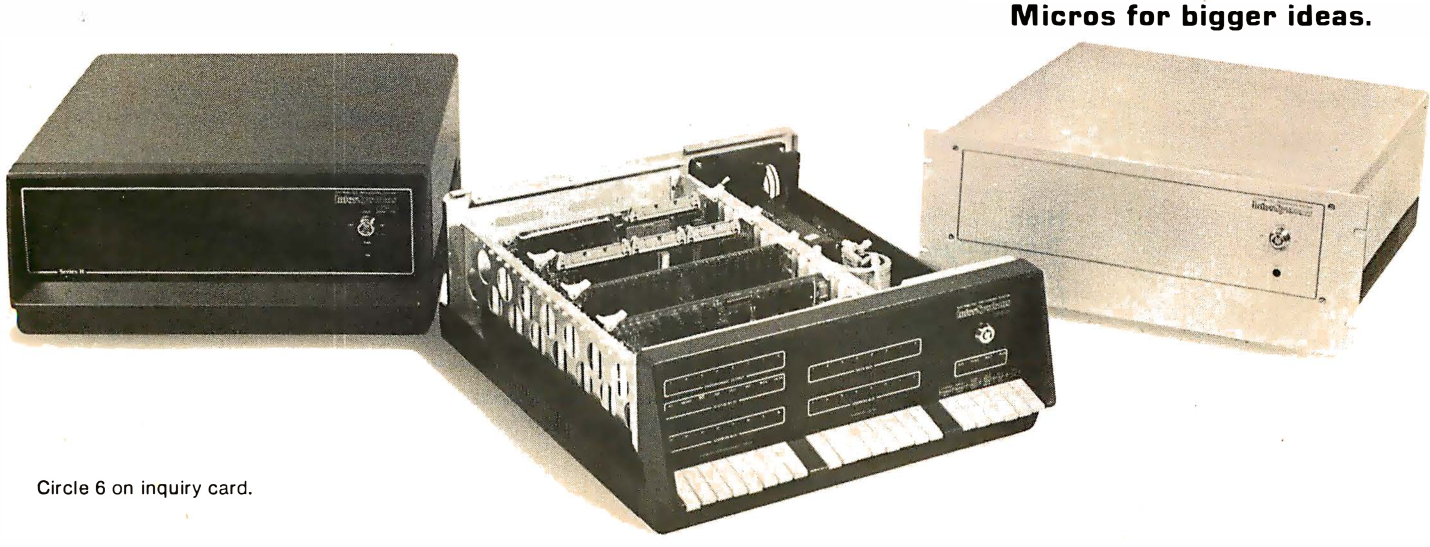
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Editorial

As VIO technology has become more readily available, there is a natural tendency to make everything from washing machines to automobiles talk back. Although the concept is a novel one, I have enough noise pollution to contend with without adding anonymous electronic voices. The real problem with voice output is that it is omnidirectional. If you're surrounded with devices that spontaneously vocalize, it's not always easy to determine where the voice came from. Picture the executive who has three or four telephones on his desk all ringing simultaneously, all sounding the same. Just as high-density video displays can cause sensory overload, multiple-voice-output devices can also overload the aural channel to the brain.

Voice recognition has taken longer to develop because of the many differences between speakers and the different shades of nuance inherent in contextual information. Factors such as the emotional content of the speaker's voice, the accent or dialect, and (the biggest problem) continuous recognition, have slowed the evolution of voice input technology. Continuous recognition means that the computer must be able to determine the beginning of one word and the ending of the last — not a trivial project. For example, the machine may have to distinguish between "I speak" and "ice peak." The problem is further compounded by regional accents and other variables. While great strides have been made in this area, it will probably be many years before generalized continuous voice recognition systems become available. Isolated word recognition is a much simpler problem, and systems are now available with better than 90 percent accuracy when working with a limited vocabulary.

With any new or evolving technology, the challenge is to use it effectively, efficiently, and with imagination. Voice input/output promises to open a whole new dimension to the man-machine interface, one that can be sensed without needing to be seen.

At the end of my *onComputing* article, "A Voice for Bill," I wrote, "I cannot even begin to imagine what uses Bill will find for his new voice. But if past accomplishments are any indication of things to come, I want to be around in five or ten years to see the results of the seeds we have planted." A year and a half later, my sentiments haven't changed a bit.

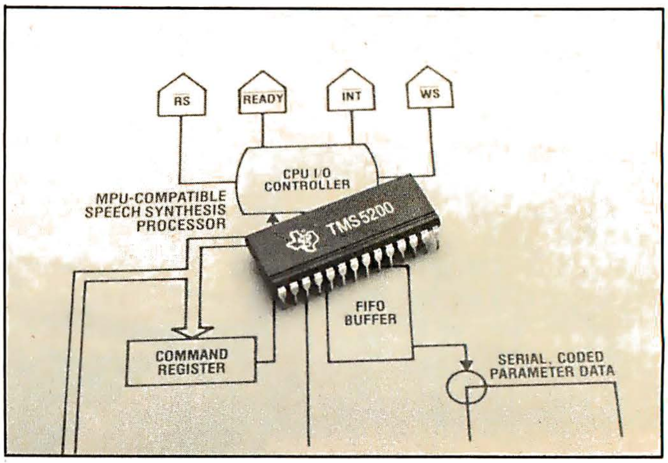


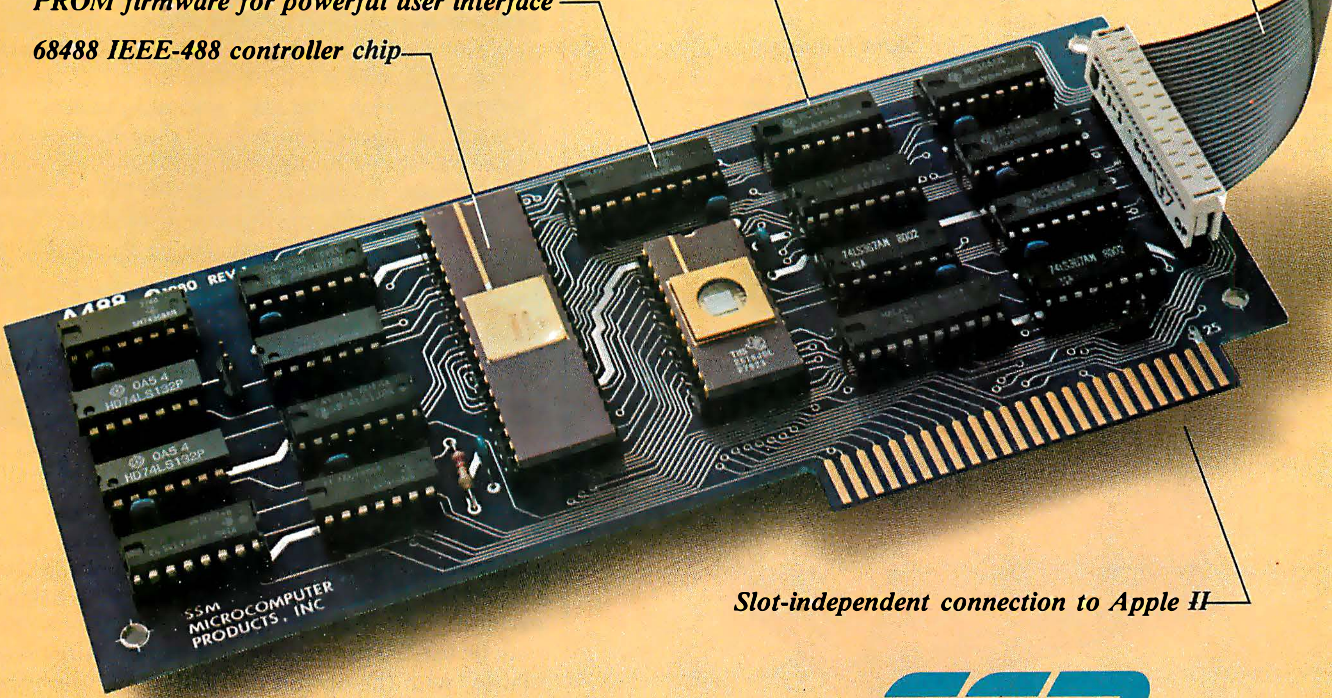
Photo 2: *The TMS5200 LPC (linear predictive coding) speech-synthesizer chip from Texas Instruments.*

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Just plug the SSM A488 board into any Apple II* expansion slot for a low-cost, full-featured instrumentation interface. SSM gives the Apple II the power and versatility of a $9,000 IEEE-488 controller. At a fraction of the price. Our board converts the Apple II into a truly sophisticated controller that programs and controls up to 15 different instruments connected together on the 488 bus.

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Editorial

I visited Texas Instruments in early November and was given a demonstration of their text-to-speech technology. The text-to-speech system uses a TMS5200 LPC (linear predictive coding) speech-synthesizer chip similar to that used in the Speak & Spell product line (see photo 2). A message may be entered in standard English, represented in ASCII. The text is then converted to allophone codes (allophones are subsets of a phoneme, the basic unit of speech) which are in turn used to retrieve LPC parameters from an allophone library stored in ROM (read-only memory). Several algorithms are used to smooth the resulting parameters and adjust the amplitude and intonation to yield continuous-sounding speech. The system has inherent advantages; the allophone tables are quite small, typically 3 K bytes for 128 allophones. Other languages may be implemented by changing the text-to-allophone rules. I experimented with a version of text-to-speech that ran on a TI 99/4 personal computer development system. It accurately interpreted the silent "e" on the end of words like "while" and "release" but misinterpreted the (nonsilent) "e" on the end of my last name, which is not surprising. When given the word "synthesizer" is said "syntheniner."

*TI is also working on a timesharing system that is similar to The Source. It will interface with the TI 99/4 and use its graphics, sound, and voice outputs. The system is completely menu driven, and will even log on for you. It sends blocks of information to the TI 99/4, each with a label indicating what kind of data is coming. In this way text, graphics, speech, and music may be sent independently. If the user's system doesn't have certain features, it simply ignores the blocks of data it can't handle. If you ask for the weather reports, it draws a picture on the screen of a sun, rain clouds, or something in between, plays an appropriate tune (ie, "Rainy Days and Mondays"), displays text giving the temperature and other vital information, and can also recite the temperature using text-to-speech. It will be interesting to see how the system is received on the consumer market....***MCD**

New Computer Speech Developments

Scott Instruments of Denton, Texas, recently announced the VET/2 — a speech-recognition interface for the Apple II. It will run with any existing software because, once loaded, either keyboard or voice input may be used. The program will handle forty-word vocabularies, with the option of overlaying other vocabularies to double or triple the number of words.

Street Electronics of Anaheim, California, has announced the Echo series of speech synthesizers. Versions are being designed for the Apple II and the TRS-80. The units use the Texas Instruments TMS5200 LPC synthesizer chip mentioned in the editorial. The software driver runs in about 900 bytes of memory. Individual vocabulary words take between 10 and 20 bytes, depending on the length of the word....**MCD** ■



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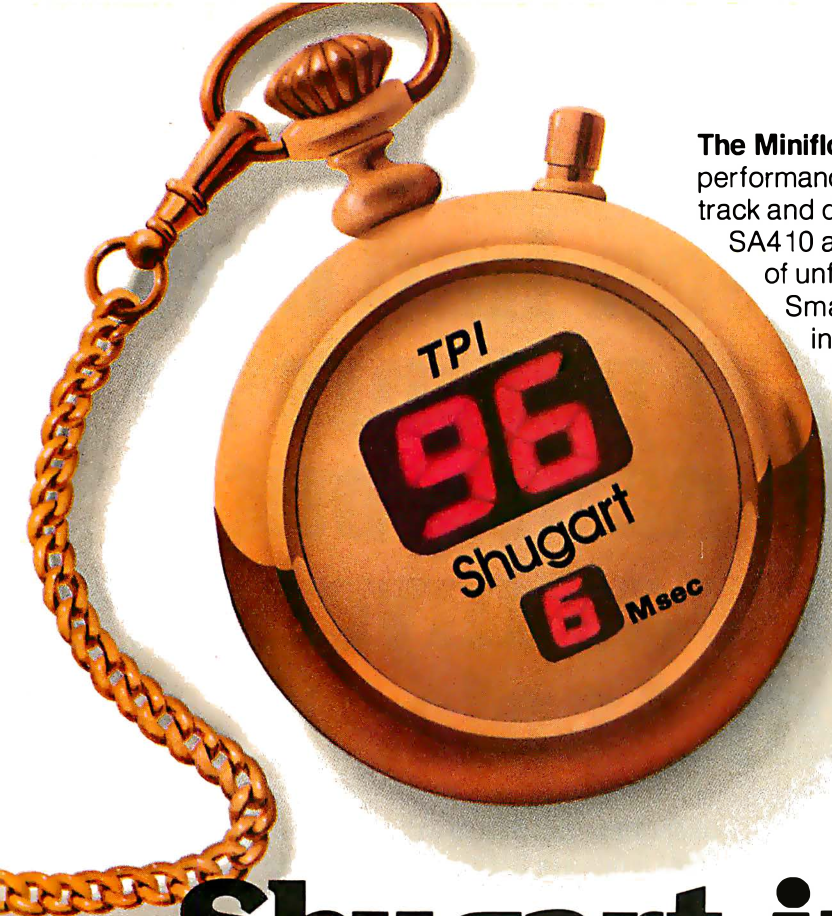
There's even a series of utility programs called the DOS Tool Kit that not only lets you design high-resolution graphic displays, but lets you work wonders with creative animation.

More illuminating experiences in store.

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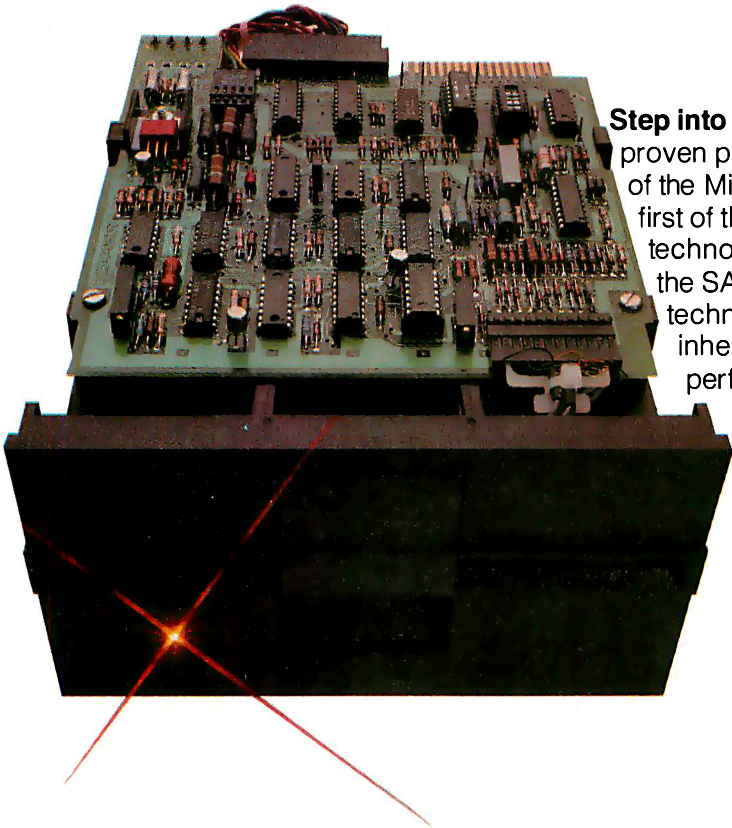
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Katching Up with Khachiyan

I would like to commend the authors of "Khachiyan's Algorithm" (G C Berresford, A M Rockett, and J C Stevenson) published in the August and September 1980 BYTEs (pages 198 and 242, respectively). Their presentation illustrated the essentials of the algorithm without getting bogged down in its derivation. However, now that I understand it (I hope), it is somewhat disillusioning to realize that the "amazing shortcut" appears to be only a nonpractical mathematical curiosity.

I have some observations regarding the algorithm. First, the huge initial volume subsequently requires the incredible precision. Hadamard's initial volume is much smaller, and this should reduce the precision requirements; but by how much? Also, if upper bounds are defined for all X_i, would this be helpful?

Even if the precision problems are solved, the total number of arithmetic operations to solve a large linear-programming problem still appears to be intractable. The upper bound for the number of iterations is $16Ln^2$, and each iteration uses Order$(n+m)^3$ multiplications for the matrix inner products. Presumably, if a solution exists, the number of iterations will be much less than $16Ln^2$ (but by how much?), and the number of multiplications per iteration can be reduced to Order$(n+m)^{2.81}$ via Strassen's algorithm. However, both of these appear to be greater than those required by the usual revised Simplex algorithm. While the Simplex algorithm can require Order(2^n) iterations, it usually finds the optimal solution in Order(m). Also, each iteration needs only Order(mn) multiplications (revised Simplex).

Memory requirements also seem to put Khachiyan's algorithm at a disadvantage. The giant **A** array (see statement 430, listing 1, September 1980 BYTE, page 246) can be reduced to negligible size using linked lists, and the **Q1** and **W** arrays could use the same space, but this still leaves three $(m+n)$ by $(m+n)$ arrays for Khachiyan's algorithm. In contrast, the only large array for the revised Simplex is the m by m B^{-1} array.

The problem of solving large linear-programming problems looks more promising if array-oriented hardware is used. For example, a clocked matrix multiplier can read in, compute, and write out the inner product of two n by n matrices in 5 n clock periods. This would be an immediate benefit for the revised Simplex as well as a help to Khachiyan's algorithm, if the precision problem can be overcome.

William J Butler Jr
44 Dees Cr
Warwick RI 02889

Berresford, Rockett, and Stevenson Reply

We are happy that you found our articles on Khachiyan's algorithm so informative. Our purpose was to encourage such experimentation with the algorithm. As the articles explained (and, incidentally, earlier than any other journal as logged in the February 1980 issue of Abstracts of Papers Presented to the American Mathematical Society*), Khachiyan's algorithm is not capable of immediate practical application largely because of the incredible precision required.*

In fairness to Leonid Khachiyan, it is clear from his paper that he never intended his result as a practical method for solving linear-programming problems. In fact, linear programming is only mentioned in one sentence in the introduction, the rest of the paper being devoted to the consistency problem for linear inequalities. His purpose was a purely theoretical one: to prove that linear consistency and, therefore, linear-programming problems could be solved in polynomial instead of exponential time. It was the American and European press (with the exception of BYTE) that erroneously construed the result as one of practical rather than theoretical importance. (In fact, many other journals have had to issue retractions or corrections of earlier ill-considered statements.)

As to your specific questions, there is little we can say except to answer "yes": your suggestions would doubtlessly improve the algorithm. Dr Philip Wolfe of IBM (Yorktown Heights, New York) has been serving as a clearinghouse and evaluator for the numerous improvements to the algorithm that have been suggested, but none so far seem to accelerate the algorithm by as much as one order of magnitude. Thus, it is far from competitive with the revised Simplex algorithm. While the Klee-Minty example shows that the Simplex method is an exponential-time algorithm, problems similar to Klee-Minty rarely occur in practice, and when they do, standard

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tricks (such as rescaling) usually greatly reduce the time needed for solution. In fact, experience seems to indicate that the revised Simplex method is almost linear in the number of variables, thus making it hard to beat.

A more complete answer to your questions about improving Khachiyan's algorithm will have to await large-scale experimentation by IBM and others.

Comments on the Heath H-89

In regard to Mark Dahmke's review of the H-89 (see "The Heath H-89 Computer," August 1980 BYTE, page 46), I agree with him until he starts talking about the "disadvantages." The text editor is not that hard to operate, and, if he thinks it is, he can get a different one from HUG (Heath User's Group) or other sources in *Buss*. He also mentions the lack of a RUN "FNAME" command in BH (Benton Harbor) BASIC, but, in version 1.6, which is the version Mr Dahmke worked with, you can say CHAIN "FNAME" with the same results.

All of Mr Dahmke's other observations are true, but there are cures. For example, to keep the disk head from banging up and down, change the HS jumper to open and the HM jumper to closed in the disk unit on the "programming plus." Then the head stays loaded as long as the motor stays on, about a minute after the last operation. Of course, you could time-delay the load signal.

The last, and probably more important, point is how not to need the HDOS system on every disk. On version 1.6, the command SET HDOS STAND-ALONE can be used and, after the warning message, the command RESET SY0: will be honored. This might mess up versions earlier than 1.6; and, if you land on a disk while not in PIP or ONECOPY, the SYSCMD.SYS will load. If the verions differ, you might get a FATAL SYSTEM ERROR, but, all in all, it is a good trade-off. Be sure to LOAD LP: and other DUDs before RESETing after BOOT up.

Bill Pinkston
Saltillo MS 38866

If I may add a few things to Mr Dahmke's review of the Heath H-89: Heath's BH BASIC is neither fast nor high in precision (my Ohio Scientific C3 will run circles around it), but it does have one great advantage for the debugging phase of programming. While other BASICs will null all variable and array values upon a revision of any line of program, however trivial, BH BASIC does not. Thus you can stop execution, fix up a defective line, and restart in mid-program, rather than having to rerun from the beginning—a real advantage for long programs, and for programs requiring many INPUTs to get going.

A detail I like about the H-89 is its ability to take commands in lowercase, converting input to uppercase as needed. That's very nice if you spend a lot of time in the word-processing mode.

Oddly, Mr Dahmke had little to say about the display and keyboard. I have to cope daily with a Televideo 912, an industrial-grade terminal which will cause you to appreciate the superior quality of the H-89 display and keyboard. The 912 is susceptible to false key contacts, which usually cause the display to do truly weird things, thereby forcing you to abandon your input and to refresh the entire display. It also gives no audible confirmation of key contact; and the 80-character line is limited to perhaps two-thirds of the screen width, wasting the rest of the screen. The H-89 terminal runs at 9600 bps (bits per second)—some have been pushed to 19,200 bps—a difference especially noticeable in word-processing and financial programs, for which execution time is limited by the display, rather than by computation.

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I have to disagree with Mr Dahmke's assertion that the Heath text editor is useless. I use it, as a word processor, for hours every day, with no difficulty; however, I'm not hampered by familiarity with any other text editors. Mr Dahmke's statement that the H-89's reading of error messages from disk takes "several seconds" is, frankly, an exaggeration. The actual elapsed time is under one second, though it certainly seems longer. Also, the disk head does *not* touch down for "each and every sector"; it reads the sectors in pairs, touching down for every *other* sector, which is noisy and slow enough.

If you want a sophisticated machine, or a fast, high-precision computer, the H-89 isn't it. The H-89 is a fine word-processing and financial computer, right for the user who doesn't want to get deeply involved in computer hardware and software.

Jack McKay
3200 19th St NW
Washington DC 20010

Mark Dahmke Replies

I thank Mr Pinkston and Mr McKay for their comments about my review, and for bringing the various "fixes" to my attention and to that of BYTE's readers. My philosophy for reviewing equipment is that I am reviewing essentially what comes out of the box. Any updates from readers are greatly appreciated, but I feel I must give potential buyers an accurate indication of what the product is like as it comes from the manufacturer. As for the other comments regarding the editor, I will stand by my statements in the review.

Dissecting the Speak & Spell Article

The article published in the September 1980 BYTE concerning the TI (Texas Instruments) Speak & Spell (see "Dissecting the TI Speak & Spell," by Michael A Rigsby, page 76) contains a number of serious errors that must have upset staff scientists Richard Wiggins and Larry Brantingham at TI's Central Research Laboratory in Dallas, Texas.

To suppose that the TMC0281 device used in the Speak & Spell is the same as the SN76477 is to greatly underestimate Texas Instruments' achievement. The TMC0281 is, in fact, a complete speech-synthesizer device fabricated in metal-gate depletion-load p-channel technology and contains an entire digital-signal processor, with timing and decoding circuits, a ten-stage digital lattice filter, and a D/A (digital-to-analog) converter. The system is based upon the relatively new voice-compression technique known as *linear predictive coding*. This technique can generate high-quality speech from low data rates (less than 2400 bits per second). Linear predictive coding is so called because of the way in which the coefficients that characterize the digital filter are predicted from a linear combination of the previous coefficients. This requires a great deal of number crunching—in the case of the TMC0281, 160,000 additions and 160,000 10- by 14-bit multiplications every second. TI confounded the many skeptics who said it couldn't be done. To get around the speed problem, Wiggins transformed all the calculations into a fixed-point format and Brantingham designed a pipeline processor that is contained within the TMC0281.

The coded speech data for the synthesizer device is stored in the TMC0351's read-only memory. These are 16,384 by 8-bit devices (ie: 128 K bits) having an internal 18-bit address counter/register and two 8-bit output buffers. Fourteen of the address bits go to the memory array directly, while the 4 most significant bits are used in a 1-of-16 chip select.

The controller chip, the TMC0271, is a slightly modified calculator chip, a member of the Texas Instruments TMS1000 family. It has been modified to enhance its BCD (binary-coded decimal) arithmetic and expand its instruction set. Also, there is an output multiplexer to reduce the pinouts needed for the Speak & Spell application.

Contrary to the implications in the article that the "operation of the Speak & spell involves many unknowns," TI has, in fact, published full details of its three-chip synthesizer system (see *Electronics*, August 31, 1978, pages 109 thru 116) and many other articles have appeared. A letter to TI brings (at least in my case) a set of reprints.

Tim Spracklen
23 Buttermere, Greenways, Spennymoor
Durham, DL16 6UD, England

De Facto of De Matter

This is a plea for order in what could be the next standards chaos: Sol Libes mentioned a Massachusetts company planning to use home VTRs (videotape recorders) for hard-disk backup. (See "Backing Up Winchesters" in "BYTELINES" October 1980 BYTE, pages 188 and 189.) Corvus also plans such a system. Our company, D C Crane Inc, is planning one using the Digital Graphic Systems CAT-100 video-display board.

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restoring hundreds of megabytes. It will also establish *de facto* interchange standards. Could we learn from the past? Just this once? Please?

I would like to hear from anyone interested in helping develop or use such a standard with a view toward documenting the problem and the solutions in an article for BYTE. If a formal standards commission is interested, so much the better. Please write me at the address below. I will put you in contact with each other and contribute my ideas toward a solution.

David C Crane
D C Crane Inc
POB 79286
Houston TX 77079

Have You Tried onComputing?

For fifteen years I have dreamed of using a computer for my one-man business. I have tried to find the right one in BYTE, on and between the lines. The result of my search is the feeling that, to become "computerized," I must become an expert in mathematics (Boolean and otherwise), electronics, hardware, software, semiconductors, integrated circuits, languages, and all the rest of the stuff. Oh, my aching head! Help, help! The computer train is rolling so fast and I am unable to climb aboard.

When I first became "motorized," I didn't have to be an expert in mechanics, thermodynamics, aerodynamics, electricity, tire structure, fuel chemistry, etc. I simply sat in the car and—without any help—taught myself the rules of the road. Who can, for a moderate price, link together and harmonize some of the wonderful programs advertised in BYTE to make a system coherent, practical, and flexible?

R E Gilbert
Jozef Hermanslei 41
B-2510 Mortsel
Belgium

Of course, a computer is much more complex than any automobile, but the analogy is still valid. People should be able to get what they want from a computer with a minimum of fuss. Until then, Mr Gilbert, guides are necessary: enjoy the complimentary copy of onComputing; *she's our sister publication for the layman.*

Sharp-Looking TRS-80

Upon studying the advertisements for the new TRS-80 Pocket Computer, I was surprised to find the letter Y's original second function (ie: ¥, for the yen on the Sharp PC 1211) deleted.

If that's the way the Tandy Corporation has to lure prospective customers into thinking that the Pocket Computer is All-American made, I pity any Japanese importer trying to sell an American computer without $tring-capability....

Marc H Bruna
Abrikozenstraat 31
2564 VK Den Haag
Netherlands

Tree Is Root of Problem

As a fellow member of the University of Oklahoma, I feel it necessary to point out some of the areas where I disagree with Dr Bill Walker's article "Sorting With Binary Trees" (October 1980 BYTE, page 96). These areas will be dealt with in the same order as they appear in the article.

First, Dr Walker gives the impression that a tree sort is both fast and allows deletion of nodes in an efficient manner. As he says, a tree sort is faster than a bubble sort, but almost any serious sort routine will be faster than a bubble sort. Likewise, deleting a node from a tree is faster than deleting an element from a bubble-sorted list, but deleting nodes from trees, except in the special cases of AVL; B; and 2-3 trees, is not particularly fast. (See *The Design and Analysis of Computer Algorithms*, by Alfredo Aho and Jeffrey D Ullman. Reading MA: Addison-Wesley, 1974.)

Second, students of graph theory tend to define a tree as an *acyclic graph.* (See *Graph Theory*, by Frank Harary. Reading MA: Addison-Wesley, 1969.) By this definition, the object presented in Dr Walker's figure 1 is not a tree, but a rooted graph.

Third, Dr Walker states that one way of scanning a sorted tree (a binary-search tree) would be to first visit the leftmost node in each branch, then the parent, and finally visit the rightmost node, repeating this sequence until finished. He proceeds to say that this is "tough for computers." However, the C-language routine in listing 1, page 24, performs Dr Walker's suggested algorithm.

Next, the algorithm used to search a tree can be cleaned up considerably, as shown in listing 2. The algorithms used to delete and add nodes are excellent, and rewriting those in C would serve no other purpose than to expose the deficiencies of Pascal.

We now have nice, short algorithms to do everything that Dr Walker wanted to do to the tree, except to delete nodes

from it. As far as I know, the algorithm he used cannot be improved upon to any great extent. This point is the basis for my statement that it is not relatively easy to delete nodes from a tree.

To achieve the operations Dr Walker wants (easy insertion and deletion, while maintaining a sorted list, plus easy searching), I would recommend a double-linked list. The algorithms for dealing with this structure can be found in any good data structures or algorithms text.

Mike Meyer, Student
University of Oklahoma
POB 1749
Norman OK 73070

I thoroughly enjoyed Dr Walker's article on binary-tree sorting in the October BYTE. He presented a subject that often receives a boring and confusing treatment in an interesting and clear manner. Since the amount of data I must sort daily has recently doubled, the article came at the right time.

Time after time I have seen the subject of trees presented in magazines and books. Each time I lacked the incentive to actually implement a tree structure on my system. The whole thing seemed too complicated for the results obtained. However, Dr Walker provided the push I needed to get it going.

Although some of the coding is redundant, by the author's own admission, and is slightly inefficient in some areas (due mostly to the direct conversion from FORTRAN and his desire to keep the program portable), the program makes sense. That sounds simple, but many programs don't make any sense at all—they just work "somehow."

Because of the use of highly structured subroutines and "standard" BASIC, I easily translated the program of his listing 1 into Oasis BASIC and modified it for operation on strings. This later change is simple if the BASIC used dimensions a string-array length rather than a string length. The modification to sort strings requires changing P in lines 200 and 205, KEY, and ALPHA to string variables. It works well and fast.

I did, however, find one major design problem. It is associated with the deletion of a right terminal node that is not the last node in the sorted sequence. Both the coding of line 3090 and the logic of table 1, Case II, Group B, Subcase 1 call for setting the right link pointer of the parent Q to NIL (setting RLINK(Q)=NIL). This tells the tree-traversal routine that this parent is the last item in the tree. Often it is not.

The proper logic is to set RLINK(Q) equal to RLINK(P). In this way, the parent Q of the deleted node P will point back to the ancestor node, the one that follows it in the sorted sequence. If the deleted node P was the terminal node of the entire tree, its parent, Q, will assume this property when the node P is deleted. That is the only problem I found.

Listing 1

```
    struct node {
            int info ;
            struct node *leftson, *rightson ;
            } ;

    visit(root) struct node *root; {

            if (root == NULL) return ;
            visit(root -> leftson) ;
            printf("%d ", root -> info) ;
            visit(root -> rightson) ;
            }
```

Next, the algorithm used to search a tree can be cleaned up considerably, as shown:

```
    search(root, item) struct node *root; {

            while (root != NULL) {
```

Listing 2

```
        if (root -> info == item)
                return(root) ;
        if (root -> info > item)
                root = root -> leftson ;
        else
                root = root -> rightson ;
        }
 return(NULL) ;
 }
```

Many thanks to Dr Walker. It was a great article; I would enjoy seeing more articles from him in the future.

Jack Dolby
335 D-1 Hiddenwood Dr
Newport News VA 23606

Screen Print for TRS-80

In the October BYTE, Teri Li's "Technical Forum" talks about some of Radio Shack's modifications for the TRS-80. (See "Radio Shack's Modifications to the TRS-80," page 182.) The screen-print problem created by the lowercase modification has a simple solution. Run the program shown in listing 1.

The screen will display: @ABCD EFGHIJKLMNOPQRSTUVWXYZ (up arrow) (down arrow) (left arrow) (right arrow) (dash)

This is how TRSDOS prints characters to the display. The alphabet codes are decimal 1 to 26. If we add 64 to each decimal value PEEKed from the display that is less than 32, then print the CHR$ equivalent to the printer, no problem will be encountered.

The program in listing 2, called as a subroutine, will print the contents of the display to a line printer.

This routine works on uppercase and upper/lowercase keyboards.

Gary E Alcorn
1037 E Redondo Dr
Tempe AZ 85282

Listing 1

```
10 CLS
20  FOR A = 15360 TO 15391
30     POKE A,B
40     B = B + 1
50  NEXT A
60 PRINT
70 END
```

Listing 2

```
5000 P=15360
5010 FOR V = 1 TO 15 : FOR H = 0 TO 63
5020 IF PEEK(P) < 32 THEN P$ = CHR$(PEEK(P) + 64) ELSE
     P$ = CHR$(PEEK(P))
5030 LPRINT P$; : P = P + 1 : NEXT H
5040 LPRINT" "
5050 NEXT V
5060 RETURN
```

Pain in the Exhaust

The article "FCC Regulation of Personal- and Home-Computing Devices," by Terry Mahn (September 1980 BYTE, page 180) has consequences for buyers and sellers of microcomputer systems that are far-reaching and not widely realized.

Compliance with the new FCC (Federal Communications Commission) regulations and the associated paperwork, testing, and certification are expensive. Personal- and business-computer systems will be more expensive after the first of January, 1981, because the consumer will be paying for compliance with these regulations.

Let me first point out that, as a licensed radio engineer, I must agree that restricting radio emissions from personal home-computing devices is both neces-

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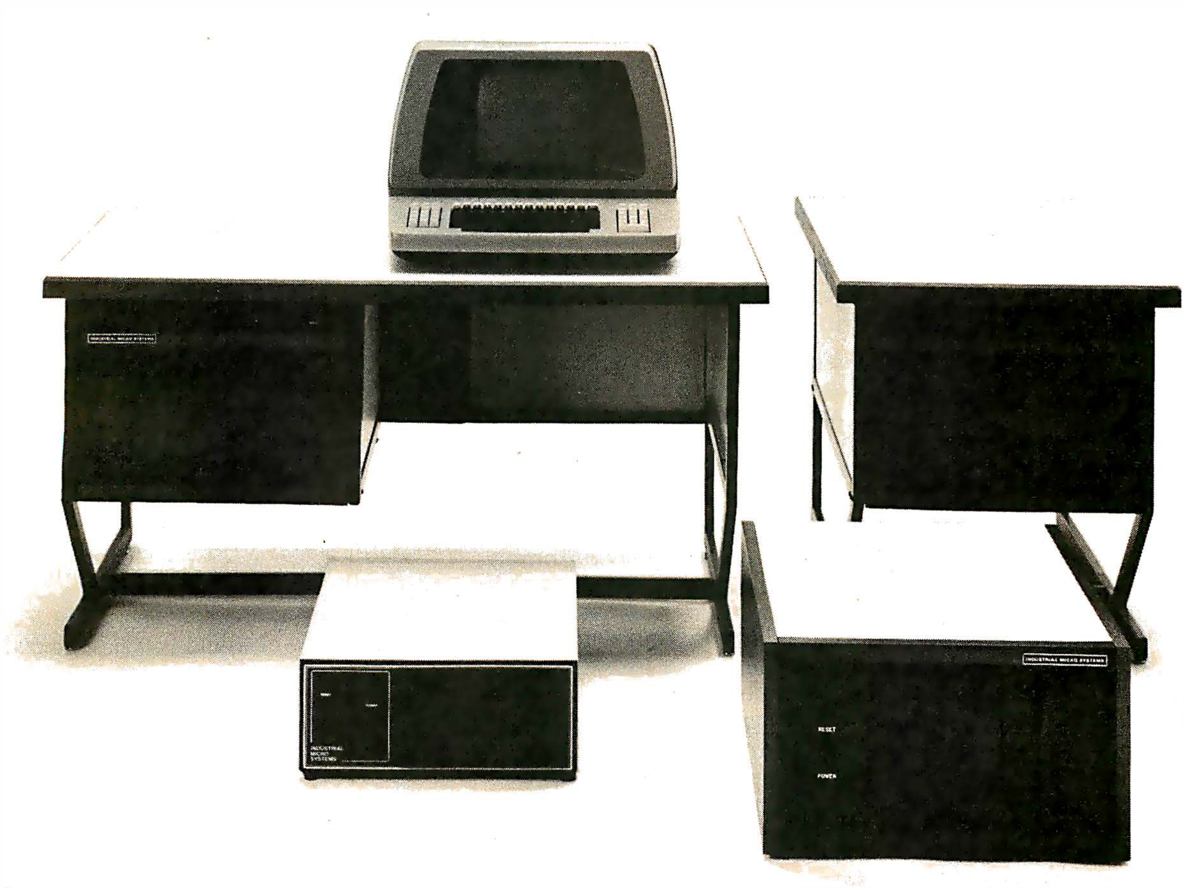
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Letters

sary and desirable. The impact of this restriction is not yet fully realized by businesses or consumers.

I will discuss both views. My company functions as an OEM (original equipment manufacturer), buying boards, cabinets, floppy disks, etc, from various companies and customizing these into systems for our customers. We are in a favorable location, where the FCC is a local telephone call away, and its testing labs, in Laurel, Maryland, are right up the street. As a business, what we have to do to legally *advertise* or sell a system after January 1, 1981, involves a lot of work and money. The testing and certification are beyond our in-house capabilities, and the necessary spectrum analyzer—even to rent—is expensive. A lab in our area will do the testing for us for $1500. Necessarily, this forces us to raise our products' prices. There, then, is even more involved paperwork and such. Now, $1500 is not a lot to the Tandy Corporation, Apple Computer, or Hewlett-Packard, but it does represent a problem for the hundreds of small computer businesses.

Also, we believe our main selling point is S-100 compatability, whereby we can choose from the wide spectrum of available boards to customize a user's system. However, if we change anything that would affect RF (radio frequency) emissions (ie: substitute a different input/output or memory board), we must recertify the "new" configuration. This will defeat any flexibility we now enjoy. The key point is that larger manufacturers can easily absorb these expenses, and we "little guys" are forced to raise prices drastically, or go out of business.

For consumers, you'll be paying more for a system that is certified to meet RF emission/interference criteria. It is hard not to draw parallels with emission-control equipment required on automobiles. In principle, it is an excellent idea. In practice, it is a pain in the exhaust, and an expense.

Having presented the problem, let me suggest some approaches. Even though this matter has been studied by the FCC for three years, it is being sprung upon manufacturers rather quickly. I believe a period of evaluation by the industry—particularly the microcomputer "cottage industry"—is in order. I have mentioned this to the FCC and to my congressman. Also, I would be happy to discuss these issues with any other interested parties.

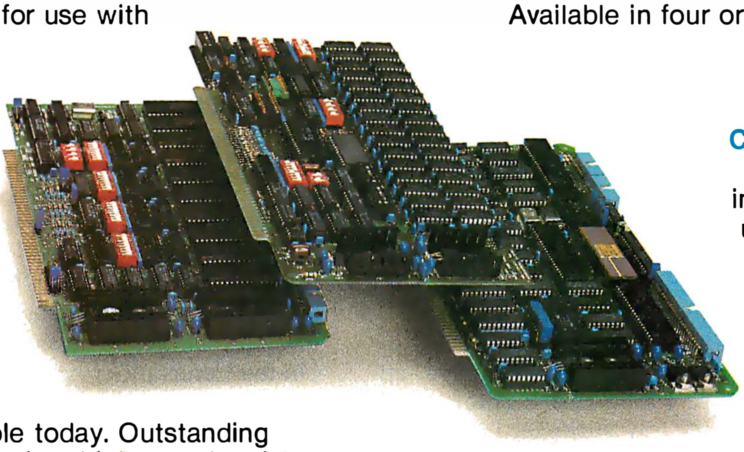
This issue represents a critical turning point for our industry and our hobby. I do not believe that many people are aware of the consequence.

Patrick H Stakem, President
Interface Technology of Maryland
POB 745
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Photo 1: *The Radio Shack Daisy Wheel Printer II.*

Radio Shack's Daisy Wheel Printer II

Yvon Kolya, POB 22, Peterborough NH 03458

In August of 1980, Radio Shack introduced a series of new products, including a daisy-wheel printer capable of producing high-quality print for word-processing systems. Radio Shack named the device the Daisy Wheel Printer II.

I was fortunate enough to be among the first to receive one of the new Daisy Wheel Printer IIs. I picked it up at the store only a week after ordering it.

Physical Appearance

As I expected, the printer had an attractive appearance, using the standard Radio Shack colors black and silver. However, much to my surprise, I found the printer to be constructed entirely of heavy-gauge cast aluminum. The only nonmetal parts were the miscellaneous knobs and switches, which were brought out to the surface of the cover for the user to manipulate, and a rubber platen. Upon opening it up, I discovered that the metal exterior was well supported by a cast aluminum interior frame, with a layer of foam rubber sandwiched between the two for sound absorption. Everything else seemed to be made of steel or chrome, except the pulley wheels, which were nylon. All in all, the printer appeared to be very solidly constructed. It was a bargain to get all this excellence for hundreds of dollars less than an equivalent letter-quality printer.

Connecting It

As soon as I had unpacked the printer from its shipping box, I plugged the carbon ribbon cartridge into place, a very simple operation, and then I pressed the print wheel into position (also a very simple operation). When I connected the printer to my TRS-80 Model II and tried it out, it worked perfectly.

I borrowed a friend's TRS-80 Model I Disk System and tried it out with the printer. It also worked perfectly the first time.

Next I connected it to an Apple II-Plus computer, using its Parallel Printer Interface Card. Unfortunately, it did not work. After a little experimentation, I discovered that the problem was with the ROM (read-only memory) software on the parallel card. Normally, the Apple's software leaves the eighth bit of the data bus set high. When it's set low, the characters on the video display flash on and off. On the Centronics printers, and their look-alikes, this bit is ignored. On the Radio Shack printer, however, the eighth bit is used for the special characters. To correct this problem, I grounded the line for the eighth bit, and the printer then worked correctly with the Apple II-Plus. I could have used a software routine to correct this problem, but I felt this method would be quicker.

Printer Controls

There are two control switches on the front of the printer, an on-line/off-line switch and the pitch-control switch. There are three modes of pitch control: *10 cpi* (characters per inch), *12 cpi,* and *proportional spacing.* The pitch control used depends upon the type font mounted in the printer. For example, if the Courier 10 font daisy wheel is in place, this switch should be placed in the 10 cpi position. If the Prestige Elite font is used, the switch setting should be 12 cpi. The Madeleine font requires that the switch be set to proportional spacing. To some minor degree, the 10 and 12 fonts can be used at either the 10 or the 12 cpi switch setting, although using

the 10 font at the 12 setting will make the letters appear cramped.

At the top of the printer are two levers, one on the right for releasing the grip of the platen on the paper, and one on the left for controlling the number of carbon copies (from 1 to 7) to be run through the printer.

At the rear of the printer are, once again, two switches. One switch is directly above the power cable, and it is used to turn the machine on and off. The other is over the interface connector; it is the *self-test switch*. The self-test switch prints out a series of characters to test both the printer and the print wheel.

Inside the printer, to the right of the cabinet, there is a three-position *impression intensity control switch*. It allows you to adjust the amount of energy used by the strike-hammer when printing.

At a Glance

Name
Daisy Wheel Printer II—catalog number 26-1158

Use
Letter-quality printer

Manufacturer
Radio Shack
1 Tandy Center
Forth Worth TX 76102

Dimensions
20.45 by 62.5 by 39.5 cm ($8\frac{1}{20}$ by $24\frac{3}{5}$ by $15\frac{11}{20}$ inches)

Price
$1960

Hardware Required
TRS-80 Model I, II, or III computer, or any computer capable of driving a standard Centronics-interface parallel printer; requires a printer-computer cable, available from Radio Shack, for whichever Radio Shack computer the printer is to be used with.

Software
None (if used with appropriate configuration of a Radio Shack computer)

Hardware Options
Tractor feed, $249 extra

Documentation
38-page manual, 22 by 28 cm ($8\frac{1}{2}$ by 11 inches), includes schematics

Audience
Computer owners desiring letter-quality printout instead of dot-matrix

Features
Print speed: 43 cps; carriage-return speed: 300 ms/$13\frac{3}{5}$ inches (34.5 cm); linefeed speed: 4 ips; printing pitch choice of $\frac{1}{10}$ inch, $\frac{1}{12}$ inch, or proportional spacing; linefeed pitch: $\frac{1}{6}$ inch or $\frac{1}{12}$ inch; fonts: 124 character positions on double-daisy print wheel; wheels: Courier 10 (supplied), Prestige Elite 12 (not supplied; catalog number 26-1421), Madeleine P S (not supplied; catalog number 26-1422); characters per line: 136 characters at 10 pitch, 163 characters at 12 pitch; impression control: high, medium, low; interfaces (physical): eight parallel and one strobe; code: Modified ASCII; paper-feed mechanism: pinch-feed platen; power requirements: 120 VAC, 50/60 Hz, 141 W 220 VAC, 50 Hz (for European operation)

Printer Attributes

This printer does not require special software for use. If you have the proper printer cable for your computer, you can use the printer immediately. While in BASIC, you can use it to print listings, or you can use it from within a program to deliver hard-copy information. If you have a word processor, such as Radio Shack's Scripsit or Michael Shrayer's Electric Pencil, you are really ready to go.

Unfortunately, both Electric Pencil and Scripsit are incapable of using all the features of this printer. For example, not all of the control codes accepted by this printer are used by these two word processors. The codes accepted by the Daisy Wheel Printer II are given in table 1.

Unfortunately, Scripsit will access only the carriage-return-with-linefeed code (decimal 13) of this printer. The rest of the codes are not used.

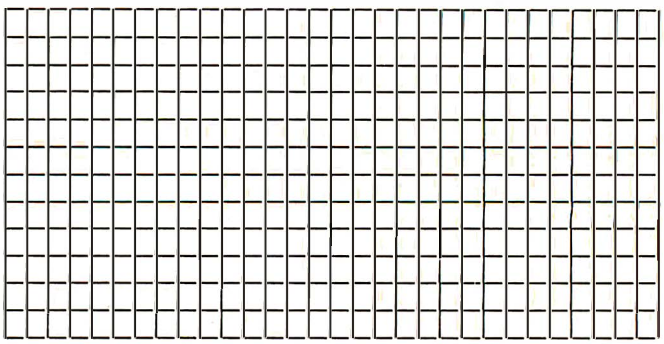
Electric Pencil is only a little bit better in that it accesses the backspace feature (to perform underlining) in addition to the carriage-return-with-linefeed code.

Fortunately, BASIC is capable of accessing all of these codes (using the function CHR$(X)); the printer's manual provides several example lines of BASIC code that can be used to do this. Listing 1 shows the first step of a maze generated on the Apple II-Plus printed by this printer. A word of caution: if your BASIC program uses the top-of-form code (decimal control code 12), you will need a special driver program for this printer. This special program is available from Radio Shack free of charge.

Although BASIC can access all of the characters and control codes used by the printer, the TRS-80 in command mode is incapable of accessing either the special control codes or about thirty characters on the print wheel because the keyboards of the Tandy Corporation computers do not generate the necessary ASCII (American Standard Code for Information Interchange) codes.

The complete character set produced by the printer is shown in listing 2. Notice that there are several foreign-language characters, as well as special nonalphabetic

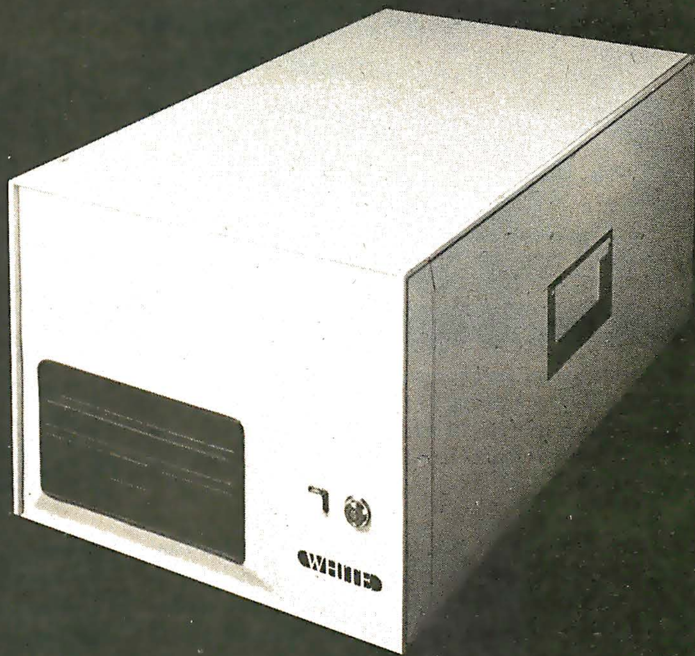
Listing 1: *A test pattern to check registration. This pattern, which is made from vertical bars and underline characters, demonstrates the printer's capabilities of great printing accuracy.*



Listing 2: *The character set of Radio Shack's Daisy Wheel Printer II. Some of the special characters can be printed only by sending special-character codes to the printer.*

```
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`
`abcdefghijklmnopqrstuvwxyz{|}~àç£µ°´†™®©¼¾½¶éùè¨ƒ§¥ÄÖÜ¢_äöüß
```


Circle 24 on inquiry card. →



How to tell if it's a White Computer.

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White Computer Company △ 1876 Industrial Way
Redwood City, California 94063 △ 415 364 7570

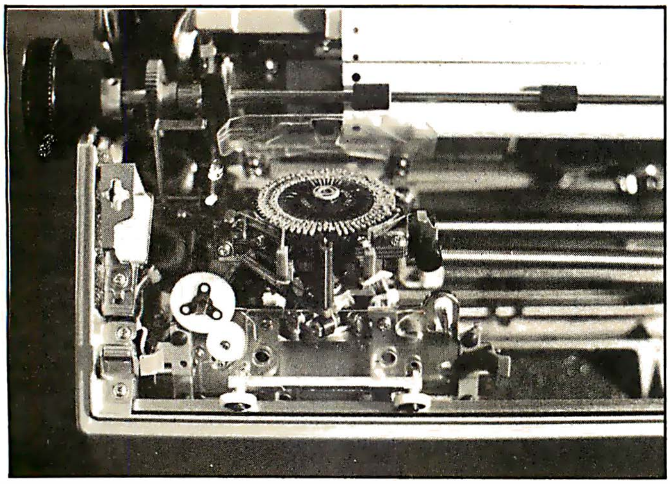


Photo 2: *The print-wheel mechanism. The print wheel is a double-daisy wheel (ie:. each prong of the wheel contains two or more characters, one closer to the center than the other). The mechanism is shown tilted back, which is the position used for changing the print wheel.*

Code (decimal)	Description
10	Linefeed, no carriage return
13	Carriage return with linefeed
27,10	Reverse linefeed
08	Backspace one character
15	Turn on automatic underline, all subsequent characters will be underlined
14	Turn off underline
27,01	Space 1/60 of an inch
27,02	Space 1/30 of an inch
27,03	Space 1/20 of an inch
27,04	Space 1/15 of an inch
27,05	Space 1/12 of an inch
27,06	Space 1/10 of an inch
27,14	Software set printer to 1/10 of an inch character-space mode
27,15	Software set printer to 1/12 of an inch character-space mode
27,17	Software set printer to proportional spacing
27,28	Half linefeed
27,30	Reverse half linefeed

Table 1 *Control codes accepted by the Radio Shack Daisy Wheel Printer II. Some of the operations are performed with a two-code sequence.*

characters. Careful study of the type font indicates that the Courier 10 print wheel supplied with the printer is capable of printing both the French and German alphabets. That's a really nice feature, if your software will allow you to generate the required ASCII codes from the keyboard.

Another worthwhile feature of this printer is a printer optimizer. If a series of linefeeds, either positive or negative, are received by the printer within 10 ms of each other, they are temporarily stored until a character code or control code is received, after which they are all performed at once. That is, if ten linefeed codes are received at less than 10 ms intervals, they are automatically stored. Upon receipt of the eleventh code, which in this example is not a linefeed, the printer moves the paper the full distance of ten linefeeds, rather than the distance of one line ten times, as other printers do.

As a last note, the documentation says that the printer uses a multistrike carbon ribbon. This means that the ribbon is advanced very slowly, with each key striking on almost the same place as the previous keystroke. Unfortunately, when the end of the cartridge is reached, you cannot rewind it and reuse the ribbon unless you disassemble the cartridge and rewind the ribbon from the take-up reel to the supply reel by hand. This is a very tedious and messy process. (I did it once when I desperately needed a printout and did not have an extra cartridge available.)

Summary

- Radio Shack's Daisy Wheel Printer II is a full-featured printer capable of providing high-quality print; it is totally suitable for use in word processors.
- The printer accepts the Centronics-standard parallel connector; thus it can be driven by any computer capable of driving a Centronics-type parallel printer (although some modification may be necessary to prevent the printing of special characters that use the eighth bit high).
- The print wheel supplied provides 124 different characters, not all of which can be produced from the standard ASCII keyboard unless a special software-driver routine is written and used.
- The printer is constructed of heavy-gauge metal and should be capable of heavy-duty use for a very long and useful life.
- According to a label on the back, the printer was made in Japan for Radio Shack. If someone had told me that Radio Shack would be selling a word-processor printer as solidly built as an NEC (Nippon Electric Company) printer or a Diablo Spinwriter, only much cheaper, I wouldn't have believed it. Now I do. ■

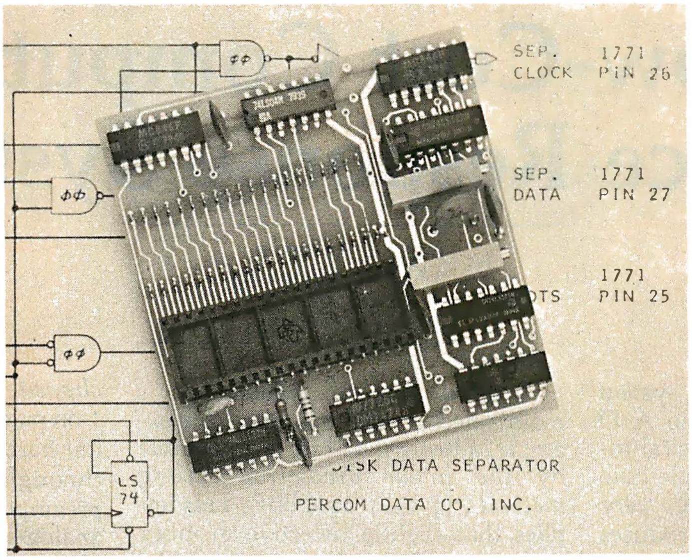
★★★ A PERCOM BULLETIN ★★★

Adapter for TRS-80* computer eliminates disk read errors

Garland, Texas — Harold Mauch, president of Percom Data Company, announced that the company is marketing a simple plug-in adapter for TRS-80* computers that corrects a design deficiency in the disk controller circuit.

The problem, which causes disk read errors, has been traced to Tandy's reliance on a circuit internal to the FD1771 controller IC to perform the function of separating clock and data pulses.

As explained in the *Backgrounder,* use of the internal chip circuit for reliable data-clock separation is a design shortcut which the manufacturer of the controller IC warns against.



Percom adapter fixes TRS-80 computer disk controller.*

The Percom solution, a PC card adapter called the SEPARATOR™, eliminates the problem by substituting an explicit data separator circuit — one which has been used reliably in Percom disk controllers since 1977 — for the internal IC separator circuit.

The SEPARATOR™ is installed without modifying the host system. The user merely removes the FD1771 IC from the host controller, installs the IC in the DIP socket on the SEPARATOR™ card, and plugs the adapter into the vacated socket of the host controller.

Percom cautions that opening the Expansion Interface of the TRS-80* computer, which is required to install the SEPARATOR™, may void the computer's limited 90-day warranty.

The SEPARATOR™, which sells for $29.95, may be purchased from Percom dealers or ordered direct from the factory. The Percom toll-free order number is 1-800-527-1592.

Payment for mail orders may be made by certified check, cashier's check or money order, or charged to a Master Card or VISA account. Texas residents must add 5% sales tax. Circle 26 on inquiry card.

Percom Mini-Disk Drives Store More, Cost Less.



Percom mini-disk drives store more data, are more reliable, yet a 40-track Percom drive costs **$100.00 less** than a 35-track Tandy drive.

You can store over 102 Kbytes per disk on Percom TFD-100™ 40-track drives, over 197 Kbytes per disk on TFD-200™ 77-track drives. A patch — supplied free on minidiskette — upgrades TRSDOS* for operation with the newer 40- and 77-track drives.

Both TFD-100™ and TFD-200™ models are available in one-, two- and three-drive configurations.

Prices start at $399 for a single-drive TFD-100™, $675 for a single-drive TFD-200™. Drives are supplied with heavy-duty power supplies. Metal enclosure is finished in compatible silver enamel.

See your nearby Percom dealer or order direct by calling toll-free 1-800-527-1592. Circle 48 on inquiry card.

Five-Inch Disks Store More Than Eight-Inch Disks!

Garland, Texas — June 25, 1980 — Percom Data Company has begun production of a double-density disk controller adapter for TRS-80* Model I computers.

Harold Mauch, president of Percom, made that announcement here today, saying that data storage capacity using the adapter and double-density disk operating system — which is included — can be increased to as much as 354 Kbytes per minidiskette.

By comparison, the maximum storage for larger eight-inch disk systems used with the TRS-80* Model I computer is about 290 Kbytes.

Mauch said the PC card adapter, which plugs into the controller chip socket of the computer Expansion Interface, works equally well for either single-density or double-density storage, and users may continue to run programs under TRSDOS*, OS-80™ and other single-density operating systems with the adapter installed.

Price, for the plug-in adapter, the TRSDOS*-like double-density DOS and a utility for converting files and programs from single- to double-density format is $219.95.

Circle 322 on inquiry card.

BACKGROUNDER

CRC ERROR! TRACK LOCKED OUT!

by the Technical Staff
Percom Data Company

This problem started while we were studying an annoying problem with the TRS-80* computer. Disk drives sold by Percom are realigned and tested before shipment. We noticed, however, that some disk drives would pass the Percom inspection but just would not work reliably on the inner tracks with a TRS-80* computer. These drives were within the manufacturer's specifications, and would function perfectly on other disk systems Percom manufactures — "perfectly" here meaning more than 50 million bytes read without error!

The disk read data separation arrangement in the TRS-80* computer Expansion Interface uses an internal data separator of the FD1771 disk formatter/controller IC. Use of the FD1771 internal data separator is not recommended by Western Digital, the IC manufacturer. The following note appears on page 17 of the FD1771 data sheet:

> Internal data separation may work for some applications. However, for applications requiring high data recovery reliability, WDC recommends external data separation be used.

We suspected the data separator because the problem was most severe on disk inner tracks where storage density is highest and data separation is most critical.

To prove our point, a technician breadboarded a standard Percom data separator circuit, and configured it to plug directly into the FD1771 IC socket of the TRS-80* computer controller.

When connected to the TRS-80* computer, a troublesome drive functioned perfectly! We ran a BACKUP utility many times and never got a track lockout. Before we added the external data separator circuit to the computer, this same drive would always lock out tracks, and would have difficulty reading from the inner (higher number) tracks.

The Percom data separator circuit fixes the mini-disk controller of the TRS-80* computer. The type of drives being used is irrelevant; the circuit eliminates disk read errors resulting from the inability of the Tandy controller design to reliably separate clock and data signals when reading high density inner tracks.

Circle 323 on inquiry card.

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PERCOM DATA COMPANY, INC. 211 N. Kirby Street Garland, Texas 75042 (214) 272-3421

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An Extremely Low-Cost Computer Voice Response System

James C Anderson
c/o MIMIC Electronics
POB 921
Acton MA 01720

A computer speech-output system can be built which requires no A/D (analog-to-digital) or D/A (digital-to-analog) converters, no multiple-pole filters, no complex hardware, very little software, and yet produces speech which is quite intelligible even to untrained listeners.

A data rate of 9600 bps (bits per second) produces speech quality and intelligibility acceptable for most hobbyist applications. This means that a 400-word vocabulary can be stored on one side of a single-density 8-inch floppy disk, the average word duration being 0.5 seconds. Similarly, the 16 hexadecimal digits, 0 thru F, can be spoken from the data stored in only 8 K bytes of memory, the average word duration for these digits being 0.4 seconds. The memory need not be high quality, and slow memory devices or components with a few random bit failures can be used. Thus, for limited vocabularies, the MIMIC speech processor may be the lowest-cost computer speech-processing system available. Other applications include:

- two-tone telephone-signal decoding
- alarm signal
- automatic word recognition by computer (using software pattern matching against stored speech samples)
- sound effects
- computer-generated musical tunes
- metronome
- rhythm generator

About the Author

James C Anderson is a graduate student at the Massachusetts Institute of Technology. He is the inventor of the MIMIC speech processor, a device similar to the one described in this article, which is manufactured and marketed by MIMIC Electronics Company.

A good deal of redundancy is maintained at 9600 bps since, for example, a lower data rate is achievable by the *linear predictive coding method* (typically 2400 bps). This implies that slightly defective memory circuits can be used for storing the speech, with essentially no degradation in speech quality (do not base the cost of a speech-storage system on high-priced memory). The low cost, high reliability, ease of use, and mass-producibility of this system make it a good choice for consumer products such as video games. Imagine what a computer could say when it finds itself losing a game (onomatopoetic responses such as "awww" are also possible).

Sixteen spoken words can easily be stored in 8 K bytes of memory.

There are basically two reasons why speech-storage memory can be inexpensive:

- The manufacturer's yield on perfect circuits plus slightly defective circuits (those with 1% of the bits bad) will be higher than the yield on perfect circuits alone.
- Memories with slow access times can be used. An access time of 10 ms is more than adequate, and circuits of this sort can be purchased at prices far below those of standard semiconductor memories.

Hardware

The technique to be used here is called *differentiated, infinitely clipped, and integrated* speech. Figure 1 on page 38 is a diagram of the essential hardware. Model speech is input through a microphone and a preamplifier (IC1). The unprocessed analog-speech signal is then used as input to a compressor consisting of an operational amplifier (or op amp, IC2), two diodes, and two resistors.

The compressor has a pseudo-logarithmic characteristic and greatly amplifies low-level signals while somewhat attenuating high-level signals. In this system, the compressor acts as a simple *automatic gain control*, making the amplitude of the speech signal at the compressor output less dependent upon such things as the human speaker's voice loudness and distance from the microphone.

The output of the compressor goes to a simple R/C (resistor/capacitor) differentiator which has a *pole* at approximately 8 kHz. The differentiator performs quite well over the entire range of speech frequencies from 100 Hz to 5 kHz (300 Hz to 3 kHz is considered "telephone quality" bandwidth for speech signals).

The differentiated analog-speech signal is then applied to a comparator (IC3) which acts as a zero-crossing detector, or infinite clipper, and turns the analog speech into a digital bit stream. A resistor is in series with the noninverting input to compensate for the input bias current of the comparator, thus preventing distortion due to "center clipping" of the signal. Only a small amount of DC offset potential in the comparator produces a large degradation in speech intelligibility.

This would complete the speech data-input path except for one problem: when no speech is present, the

Speech Processing

Many techniques now exist for speech processing or digitization (the encoding, storage or transmission, and subsequent decoding of data for speech signals). Some techniques have definite advantages over others depending upon the application.

For example, phoneme *synthesizers, which are essentially electrical analog models of the human vocal tract, can produce speech from very low data rates (600 bps (bits per second) or less) and are often used in systems where bandwidth or memory is at a premium. By contrast,* time-domain *techniques such as* delta modulation *require greater bandwidth (9600 bps or more) and are popular when a mass-storage device (eg: a disk drive) is available. Time-domain techniques simply record speech-signal parameters as a function of time, and may or may not make use of human-vocal-tract characteristics to help reduce memory or bandwidth requirements.*

Cost constraints often determine which type of speech processor will be used in a system. Synthesizers can be costly both in terms of the initial hardware investment and in the programming and testing time required to convert words into phoneme strings. Neither of these costs is likely to be reduced significantly. It is often more cost-effective to invest in equipment of general utility, such as a floppy-disk drive, and use a low-cost time-domain speech processor. Many forces are acting to drive down the cost of mass storage. For example, optical recording technology has produced a 30 cm disk with storage capacity of 10 billion bits and data-access times compatible with speech-processing requirements. Assuming the speech data has been sampled at a rate of 16,000 bps, such a disk can store enough data to produce speech continuously for more than a week.

Many of the time-domain techniques for speech processing have significant drawbacks. Pulse code modulation, *as used in telephone-quality systems, requires a high data rate (64,000 bps) and is therefore seldom considered for present-day computer speech applications.* CVSD (continuously variable slope delta) *modulation produces good-quality speech from a 16,000 bps data stream, and several manufacturers have recently introduced CVSD integrated circuits (MC3417 by Motorola, HC-55516 by Harris Semiconductor, and FX-209 by Consumer Microcircuits of America are examples). However, all the CVSD units are sole-sourced (ie: noninterchangeable with other units).*

Each of these components requires a considerable amount of support circuitry for operation, including a power supply, microphone preamp, audio power amp, and complicated filters which use precision (1%) capacitors and resistors. Perhaps the greatest drawback to CVSD is the fact that the speech data stream which a CVSD chip produces is meaningful only to another CVSD chip.

For example, if the highly encoded CVSD speech data is to be used for automatic word recognition, it must first be decoded by some rather time-consuming software before any operations such as frequency analysis can be performed. CVSD data also proves to be difficult to "conference" (mix) in communication networks, when several users are talking simultaneously to a single listener.

When time-domain techniques are used to store a large vocabulary in memory, it often becomes a difficult and time-consuming task to reproduce the words in the vocabulary at the same volume level. This occurs because it is nearly impossible to hold the microphone in the same manner and to speak always at the same volume level when originally recording the vocabulary. It is also difficult to add new words to an existing vocabulary for the same reason. A similar problem arises when attempting automatic speech recognition *with a computer, since variations in volume produce variations in the speech data pattern. Such variations must usually be eliminated by a lengthy amplitude-normalization process in software.*

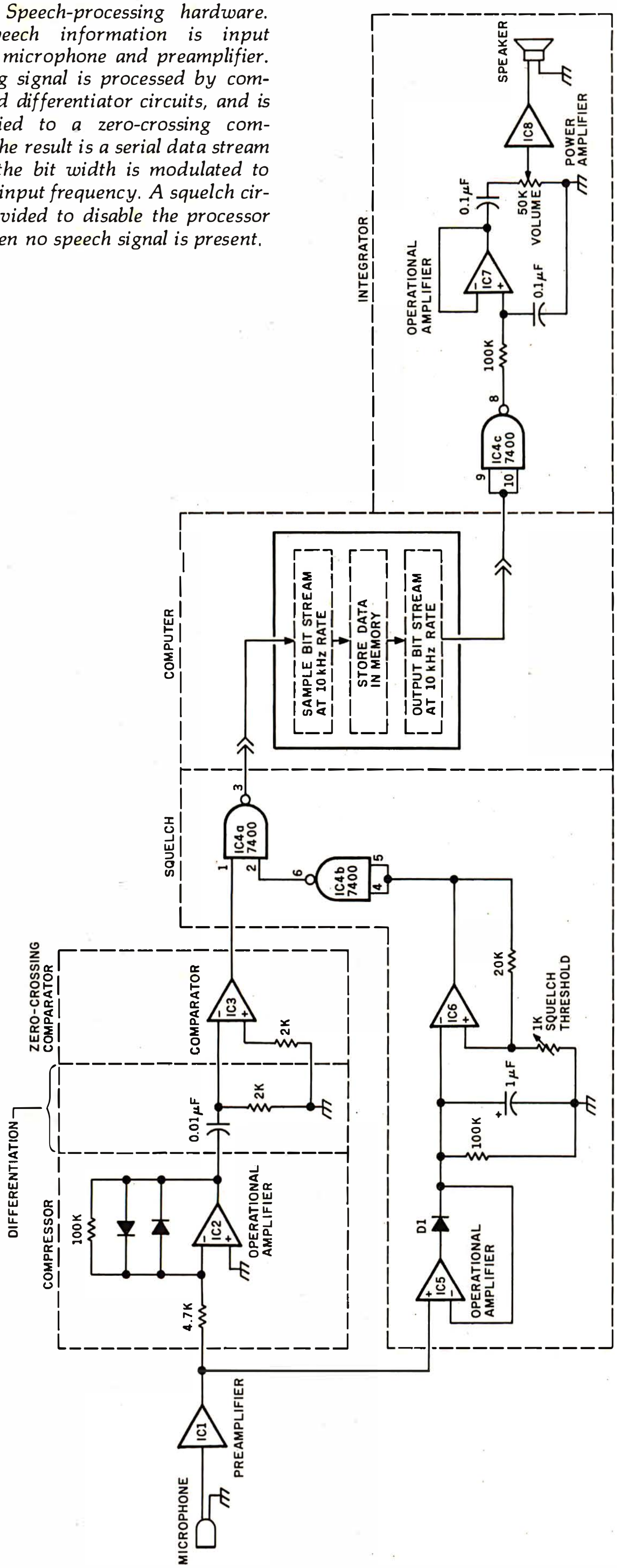
The MIMIC Speech Processor presented in this article is a low-cost time-domain system which has a relatively low bit rate. Using only standard components, the MIMIC Speech Processor requires minimal external hardware for operation. The data produced is not highly encoded, and is therefore easy to analyze and use in communication networks. The MIMIC Speech Processor automatically normalizes the amplitude of all audio input signals, and is therefore not subject to the problem of volume variation.

Speech Intelligibility

A common method for evaluating speech intelligibility is the "articulation test." Typically, a person reads a list of syllables or unrelated words to an "untrained" group of listeners (recognition ability improves with practice), and the percentage of items identified correctly is taken as the articulation score. By choosing test material representative of the sound statistics of a language, a realistic test of the system can be made. Word-articulation scores for speech which has been differentiated, infinitely clipped, sampled at a 10 kHz rate, and integrated (in that order) are in the neighborhood of 90% for trained listeners.

When words are used in sentences, contextual information is present which leads to considerably higher articulation scores. To test your system, try recording the sentences "Joe took father's shoe bench out," and "She was waiting at my lawn." Together, these sentences contain all of the fundamental sounds in the English language that contribute toward the loudness of speech.

Figure 1: *Speech-processing hardware. Model speech information is input through a microphone and preamplifier. The analog signal is processed by compressor and differentiator circuits, and is then applied to a zero-crossing comparator. The result is a serial data stream in which the bit width is modulated to reflect the input frequency. A squelch circuit is provided to disable the processor output when no speech signal is present.*



comparator (IC3) puts out unpleasant high-frequency noise. This problem is overcome by controlling the processed speech-data signal with a *squelch* signal.

The squelch circuit uses amplitude information to shut off the data stream through IC4a. When the overall magnitude of the unprocessed input signal is above a certain threshold value, the circuit quickly enables the data to pass. Op amp IC5, diode D1, and the R/C output filter form an envelope-detector system which follows the positive peaks of the unprocessed speech signal. A comparator with hysteresis (IC6 and its voltage-divider feedback network) is used to give the squelch circuit a fast attack response, but a slow decay characteristic. Thus, the differentiated and infinitely clipped digital speech data stream is created, and squelched when necessary.

The processed speech, in the form of a bit stream, may then be sampled by a computer or other digital hardware at a rate of approximately 10 kHz. The information may be stored in some type of memory, and used later to produce speech.

To reproduce stored speech, the information is dumped at a 10 kbps rate. The speech-output hardware is a filter consisting of IC4c and an R/C network which has a pole at approximately 16 Hz. The buffer (IC7) feeds an AC-coupled power amplifier (IC8) with volume control. The speech produced by this digital recording system has essentially been differentiated before storage, then integrated upon playback.

Quality

Although the storage requirement is typically 10,000 bits for each second of speech, the effective amount of storage required can be reduced somewhat by using phoneme concatenation. For example, the spoken word "seven" can be stored as an "s" sound plus an "eh-vun" sound. The same "s" sound can also be used in other words such as "six " ("s" plus "ick" plus "s"). Similarly, one recording of the word "teen" will allow you to generate "seventeen" with a simple program which outputs "s" plus "eh-vun" plus "teen."

This method, unfortunately, will not always produce acceptable speech. When "dog" is broken up into "duh" plus "aw" plus "guh," the

resulting audio does not sound like the intended word. This is due to the fact that in natural-sounding speech, the end of one phoneme often blends into the start of the next (but not always, as was shown in "seventeen"). If all of the phonemes are recorded separately, some method is needed to blend them together—a formidable task.

The speech quality of this system is similar to a single-side-band radio signal which is not quite tuned in. The speech produced is quite intelligible yet rather "mechanical" sounding. However, upon listening to speech produced by this system, several people have remarked that it "sounds just like you'd expect a computer to sound when it talks." Thus, it seems to have good public acceptance as far as quality is concerned.

Theory

Why does such a simple system work? The answer is not particularly simple. However, an understanding of the theory can point to methods for improving the speech quality and can also give a feel for the system's limitations. During World War II, it was discovered that a large amount of peak clipping could be impressed on a speech signal with the speech remaining at least moderately intelligible.

Infinite clipping is a process which preserves only the zero-amplitude axis-crossing information of the speech waveform (ie: the process tells us whether the signal is positive or negative). The intelligibility of an infinitely clipped speech signal can be dramatically improved if the clipper is preceded by a differentiator circuit. A simplified conceptual diagram of the hardware is presented in figure 2, which omits the squelch circuit. The system input $f(t)$ in figure 2 corresponds to the compressor output (IC2) of figure 1.

The spoken word "seven" can be stored as an "s" sound plus an "eh-vun" sound.

Mathematically, taking the derivative of a function and equating it to zero yields the local maxima and minima (peaks and valleys) of the original function. For example, assume that the system input in figure 2 is a sine wave, $f_1(t)$, as shown in figure 3a on page 40. This sine wave is differentiated so that the cosine wave, $f_1'(t)$, of figure 3b is present at the input to the comparator. Notice that whenever $f_1'(t)$ equals zero, as at $t=\pi/2$, the original function $f_1(t)$ is at a peak or a valley.

In the next step of processing, the comparator acts as an infinite clipper. The comparator output is high when $f'(t)$ is greater than zero, which means that the original function $f(t)$ has a positive slope and is rising from a valley to a peak. Similarly, for $f'(t)$ less than zero, the comparator output is low, which means $f(t)$ is going from a peak to a valley. When $f'(t)$ equals zero, a critical point is occurring and the comparator output is changing. The comparator output is an infinitely clipped version of $f'(t)$ as shown in figure 3c. This may be sampled and stored as digital information.

An approximation to the original function $f(t)$ can be obtained by integrating the stored digital information (see figure 3d). Note that only a triangular-type waveform can be obtained at the integrator output because the input to the integrator is always a *bivariate* (two-level) waveform. However, a triangle wave is a close approximation to a sine wave. In fact, the triangle wave of figure 3d is given in Fourier-series form as:

$$(4/\pi)\left[\sin t - (1/9)\sin 3t + (1/25)\sin 5t - (1/49)\sin 7t + \ldots)\right]$$

The components other than the fundamental ($\sin t$) can be considered as contributions to distortion and can be reduced by filtering. In general, a DC offset may also be present, but any offset can easily be eliminated in the actual implementation simply by using AC-coupled amplifiers. In summary, the system of figure 2 will provide a triangle wave which can only approximate the original sine wave.

Amplitude Decoding

In the system of figure 2, the frequency of the "reconstructed" waveform (at the output) will be the same as the original input frequency. However, the output waveform's

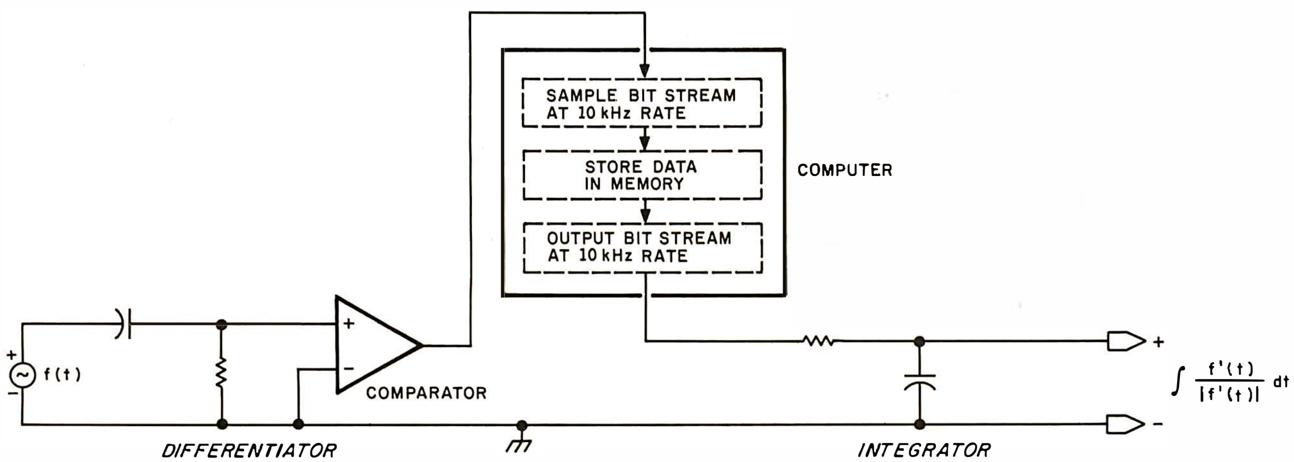
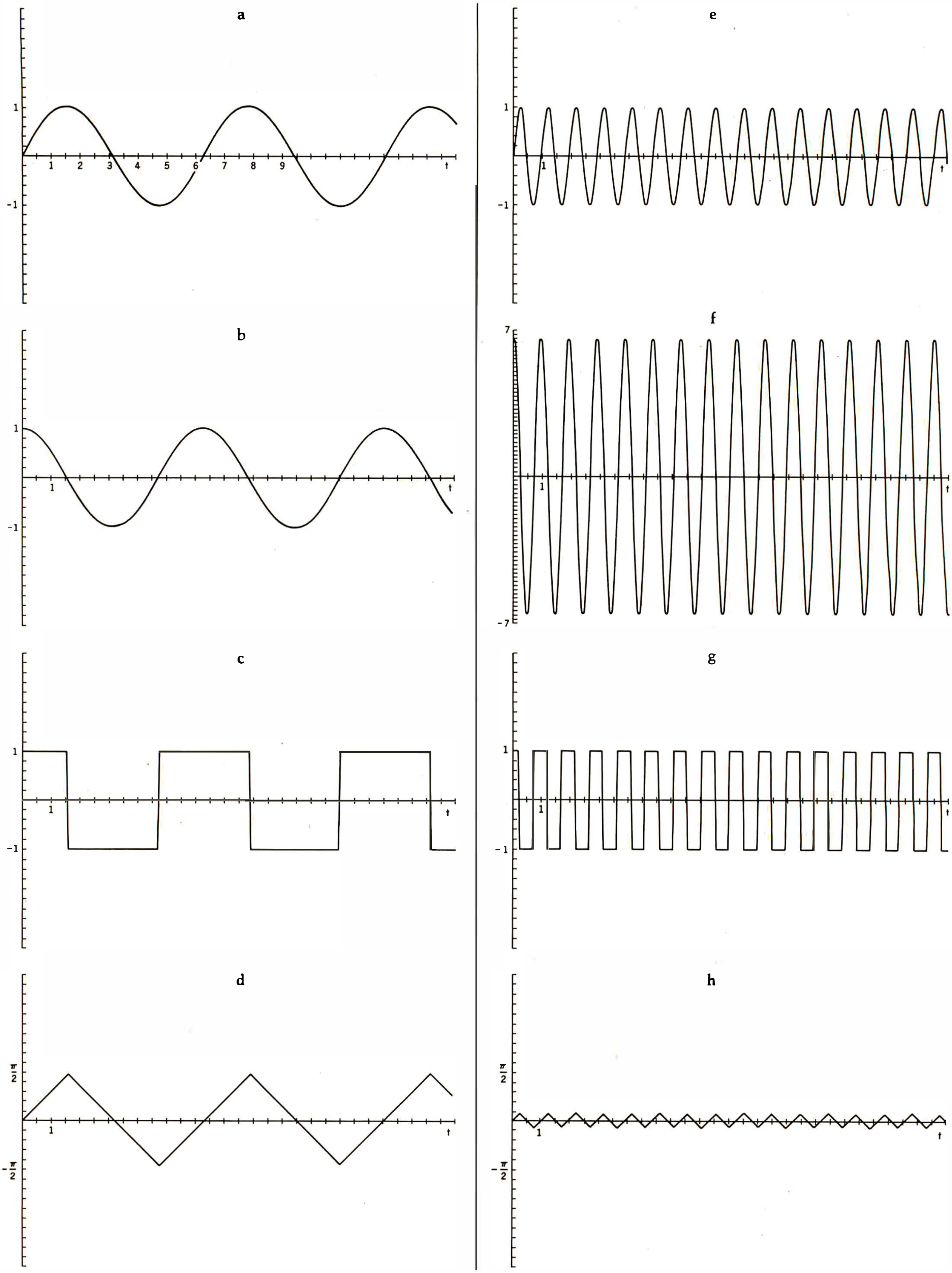


Figure 2: *Diagram of the processing concept. This simplified diagram omits the squelch and compressor stages of figure 1. The process is easy to follow: any analog input is differentiated and clipped before storage as a digital bit stream; upon playback, the bit stream is simply integrated to recover the original waveform information.*


a
1
-1
1 2 3 4 5 6 7 8 9
t
b
c
d
$\frac{\pi}{2}$
$-\frac{\pi}{2}$
e
f
7
-7
g
h

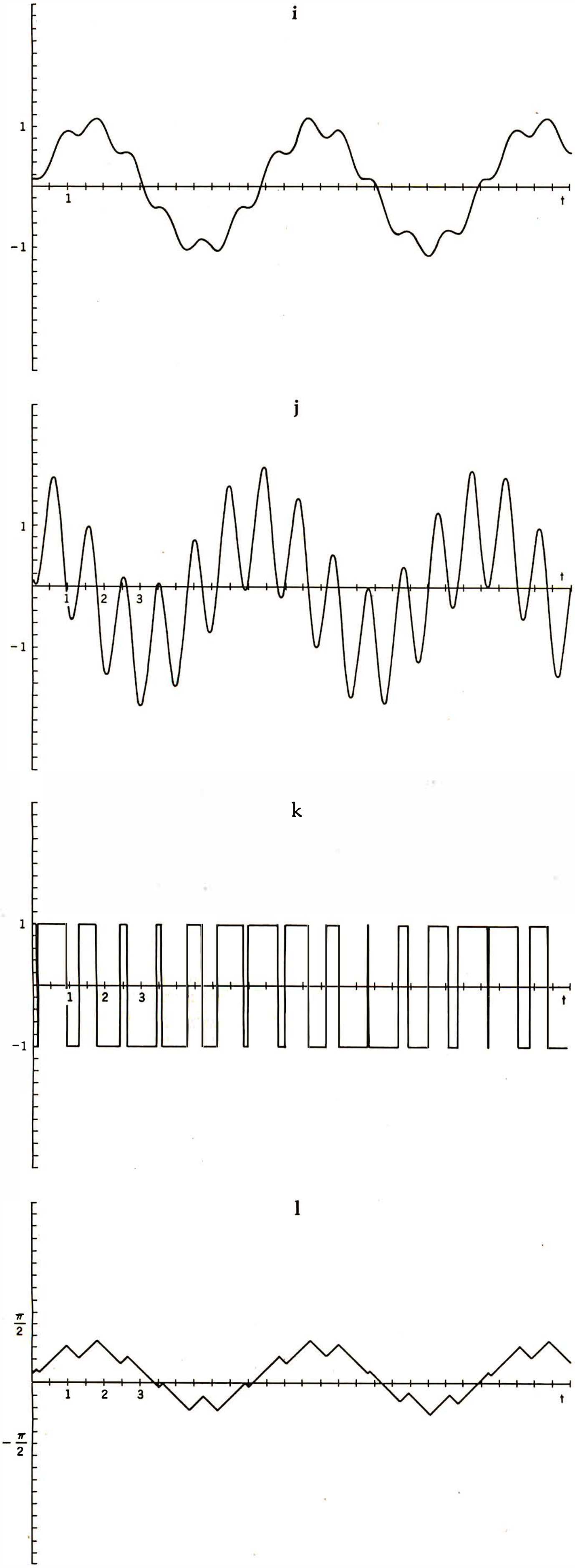


Figure 3: *The basic process is illustrated on the first four waveforms. If a sine wave (a) is fed to the processor ($f_1(t)$ =sin t), the wave will be differentiated to produce a cosine wave (b) ($f'_1(t)$ =cos t). Notice that the cosine wave crosses zero whenever the sine reaches a peak. This is also reflected in the output of the* infinite clipper *stage (c) where the waveform may be expressed as: $f'_1(t)/|f'_1(t)|$. At this point, the information may be stored digitally. An approximation of the original signal (f(t)) can be obtained by integrating the stored information to produce (d):*

$$\int \frac{f'_1(t)}{|f'_1(t)|}\,dt$$

Although the output waveform has the same frequency, the amplitude is not always accurately reproduced, since the comparator has a constant amplitude output regardless of input signal level.If the signal shown in (e) is fed to the speech processor ($f_2(t)$=sin 6.5t), the differentiator will produce the wave of (f) ($f'_2(t)$=6.5cos 6.5t). The zero-crossing comparator produces the square wave of (g) ($f'_2(t)/|f'_2(t)|$), which may be recorded quite accurately. When this information is played back, the wave of (h) will be produced:

$$\int \frac{f'_2(t)}{|f'_2(t)|}\,dt$$

The amplitude is reduced because the integrator stage is essentially a low-pass filter. The same process is performed on more complex waveforms as shown:

(i) $f_3(t) = \sin t + \frac{1}{6.5} \sin(6.5t + 2.3)$

(j) $f'_3(t) = \cos t + \cos(6.5t + 2.3)$

(k) $f'_{3clipped}(t) = \frac{f'_3(t)}{|f'_3(t)|}$

(l) $\int f'_{3clipped}(t)dt = \int \frac{f'_3(t)}{|f'_3(t)|}\,dt$

Note that the overall wave shape and relative amplitudes are well preserved.

---

amplitude will diminish as the frequency increases; and it will do so regardless of the input amplitude. For example, assume that the input to the system is $f_2(t)$=sin 6.5t, as shown in figure 3e. The output of the differentiator is then $f'_2(t)$=6.5 cos 6.5t, which is a large-amplitude cosinusoid (see figure 3f). This signal is applied to the comparator and the square wave of figure 3g results, with an

amplitude independent of the input-signal amplitude.

The square-wave signal is now run through an integrator, which drastically diminishes the amplitude of the signal (see figure 3h). This is so because an integrator acts as a low-pass filter, and causes a signal's amplitude to diminish in inverse proportion to its frequency (ie: it attenuates higher frequencies by 20 dB per decade of increase in frequency). Thus, the amplitude of $f_2(t)$ was not preserved in the reconstruction, even though the frequency was.

The clipped-speech approach presents an alternative to more complex and costly systems.

We can get an accurate reconstruction of both frequency and relative amplitude only if we guarantee that the input waveform will diminish in amplitude as a function of its frequency. For example, $(1/a)\sin(at)$ is such a signal, when a is an arbitrary real (nonzero) constant. Thus, if we had applied $(1/6.5)\sin 6.5t$ to the system (instead of just $\sin 6.5t$ as in the previous example), the output would have been a reconstructed waveform of both proper frequency and amplitude.

The system of figure 2 is therefore limited to reconstruction of signals which fall off in amplitude by 20 dB/decade. Figures 3i, 3j, 3k, and 3l show what the system does to a more complicated signal which meets the restriction. The important thing to note is that the wave shape (and hence the frequency content) of the original signal is faithfully reproduced, and the relative amplitudes are maintained.

Speech signals (eg: a voltage waveform produced by a microphone whose output is linearly proportional to pressure) generally have amplitude components which drop off as a function of frequency by about 20 dB/decade. This is true for both short-term (125 ms) and long-term (a minute or so) measurements. Hence, one would expect the system of figure 2 to be capable of reproducing fairly natural-sounding speech which, indeed, it does.

Actually, differentiated-clipped speech is just as intelligible as differentiated-clipped-integrated speech (ie: no new information is produced by simply integrating the bivariate waveform at the comparator output), but it is very unpleasant to listen to. Some types of music can also be recorded using this system, with recognizable melodies and harmonies.

Distortion

Distortion may come from several different locations in this system of speech recording and playback. If, for example, the input signal does not have components which fall off in amplitude by exactly 20 dB/decade, there is no hope for an "exact" playback using the circuit of figure 1. This situation arises when several persons are speaking simultaneously at different levels of loudness. The voices tend to mask or distort each other. A similar situation occurs when one person talks in a noisy environment. Another source of distortion comes from the fact that the system can produce only ramp-type

Listing 1: *The author's MIMIC driver. Assembled on Cromemco's CDOS for Z80s, this routine should work equally well on any 8080-based microcomputer. As noted in the comments at the top, this software should produce a 10 kbps data rate for systems with a 2 MHz clock.*

```
                ;EXAMPLE: MIMIC DRIVER PROGRAM
                ;8080 OR Z80 INSTRUCTIONS
                ;ASSUMES 4 K OF MEMORY AT LOCATIONS 0 TO FFF
                ;ASSUMES MIMIC INTERFACED AT PORT B3 HEX
                ;ASSUMES 2 MHZ CPU CLOCK
                ;RESULTING SPEECH DATA RATE IS 10 KHZ
                ;
0000                  ORG  0          ;PROGRAM STARTS AT ZERO
0000  214800    VIN   LD   HL,BUF     ;ADDRESS BUFFER MEMORY
0003  0E08            LD   C,8        ;INITIALIZE BITCOUNT
0005  DBB3      V1    IN   A,0B3H     ;DIG OUT ACTIVE?
0007  17              RLA             ;CHECK FOR BIT 7 SET
0008  DA0500          JP   C,V1       ;WAIT FOR IT
000B  DBB3      V2    IN   A,0B3H     ;GET DATA BIT FROM MIMIC
000D  1F              RRA             ;SHIFT BIT ZERO INTO CARRY
000E  7E              LD   A,(HL)     ;GET DATA BYTE
000F  1F              RRA             ;PUT BIT INTO BYTE
0010  77              LD   (HL),A     ;STORE DATA IN BUFFER
0011  0D              DEC  C          ;COUNT BIT
0012  C21E00          JP   NZ,V3      ;DONE WITH BYTE?
0015  0E08            LD   C,8        ;RESET BITCOUNT
0017  23              INC  HL         ;MOVE POINTER
0018  7C              LD   A,H        ;SET UP FOR COMPARE
0019  FE10            CP   010H       ;AT 4 K BOUNDARY?
001B  CA2400          JP   Z,VOT      ;YES, NOW PLAY BACK DATA
001E  CD4100    V3    CALL DEL        ;100 MICROSECOND WAIT
0021  C30B00          JP   V2         ;LOOP AGAIN
                ;
0024  214800    VOT   LD   HL,BUF     ;ADDRESS BUFFER MEMORY
0027  0E08            LD   C,8        ;SET BITCOUNT
0029  7E        VT2   LD   A,(HL)     ;GET DATA BITS
002A  D3B3            OUT  0B3H,A     ;OUTPUT DATA TO MIMIC
002C  0F              RRCA            ;ROTATE BITS IN DATA BYTE
002D  77              LD   (HL),A     ;STORE DATA BYTE
002E  0D              DEC  C          ;COUNT BIT
002F  C23B00          JP   NZ,VT3     ;DONE WITH BYTE?
0032  0E08            LD   C,8        ;RESET BITCOUNT
0034  23              INC  HL         ;MOVE POINTER
0035  7C              LD   A,H        ;SET UP FOR COMPARE
0036  FE10            CP   010H       ;AT 4 K BOUNDARY?
0038  CA2400          JP   Z,VOT      ;YES, REPEAT AD INFINITUM
003B  CD4100    VT3   CALL DEL        ;100 MICROSECOND WAIT
003E  C32900          JP   VT2        ;LOOP AGAIN
                ;
0041  0609      DEL   LD   B,9        ;CALIBRATE CONSTANT FOR DELAY
0043  05        D2    DEC  B
0044  C24300          JP   NZ,D2      ;LOOP UNTIL DONE
0047  C9              RET
                ;
0048  00        BUF   NOP             ;START OF BUFFER MEMORY
                ;
0049  (0000)          END
```

waveforms at its output, no matter what the input looks like.

With additional hardware and software, these problems can be greatly overcome, resulting in an improvement in speech quality. If, instead of a simple squelch circuit, the slowly varying amplitude-envelope signal is sampled with an A/D converter, and if this data is used to amplitude-modulate the constant-level clipped speech signal when it is reproduced for output, the quality of the signal is improved. However, the overall data rate required is approximately 15,000 bps, and requires additional hardware. The system of figure 1 is about the best we can do in terms of simplicity and cost when it comes to low-bandwidth speech processing.

Sample Rates

If one is to use clipped speech as a digital recording technique, distortion due to a finite sampling rate must be considered. Figure 1 shows a typical system for recording a vocabulary of selected words which may later be used for computer voice response. Experiments have shown that highly intelligible speech can be obtained with a sampling rate of about 10 kHz. Note that this sampling rate is an experimental result and has nothing to do with the well-known sampling theorem, which states that the rate of sampling must be at least twice the highest frequency to be recorded, in order to ensure an accurate reproduction. Here we are essentially sampling a square wave, which is not a band-limited signal.

To understand why the 10 kHz sampling rate is adequate, consider the fact that the human ear loses resolution at high frequencies. For example, the note A above middle C has a fundamental frequency of 440 Hz. The next note above it (A sharp) has a frequency of $440 \times \sqrt[12]{2}$, or approximately 466 Hz. The highest A on the piano, which is 3 octaves above 440 Hz, has a frequency of $2^3 \times 440$ or approximately 3520 Hz. Similarly, the highest A sharp has a frequency of $2^3 \times 466$, about 3729 Hz.

The difference between 440 Hz and 466 Hz sounds the same as the difference between 3520 Hz and 3729 Hz, even though the actual frequency difference is 26 Hz versus 209 Hz. Thus, our ability to resolve frequencies deteriorates rapidly with increasing frequency. In the case of clipped speech, time quanta of about 0.1 ms are adequate and the ear cannot easily discern errors introduced in the frequencies which are reproduced. Sampling clipped speech at rates much higher than, say, 20 kHz merely wastes computer memory while offering no appreciable improvement in speech quality.

Final Note

It appears that clipped speech techniques can be used in cases where a limited-vocabulary computer voice response is needed. In terms of simplicity, ease of implementation, and low cost, it is probably optimal. For persons on limited budgets such as students, hobbyists, and even professional electrical engineers (who see applications for computer speech output but would have trouble justifying a large investment), the clipped-speech approach presents an alternative to more complex and costly systems. ■

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A Computer-Controlled Tank

Steve Ciarcia
POB 582
Glastonbury CT 06033

My guess is that when you first scanned the title of this article and a few of the photos, you immediately recognized Milton-Bradley's Big Trak. Perhaps it was one of the gifts your children received during the holidays.

Big Trak, shown in photo 1, is a computer-controlled, motorized toy tank. Commands to move, to turn, and to fire the "photon cannon" are programmed by a user (via a keypad) into the tank's control system. After the user presses the "Go" key, Big Trak takes off, executing the stored command sequence.

Big Trak's keypad contains a key for each command. Some commands are completed with a single keystroke, while other commands require multiple keystrokes for the entry of parameters. A list of command functions appears in table 1.

Commands may be chained and carried out sequentially. For example, pressing the sequence: Forward, 2, Left, 3, 0, Hold, 1, 0, Fire, 3, Go, causes the tank to drive forward 2 feet, pivot 180°, wait 1 second, and then fire three cannon blasts. This se-

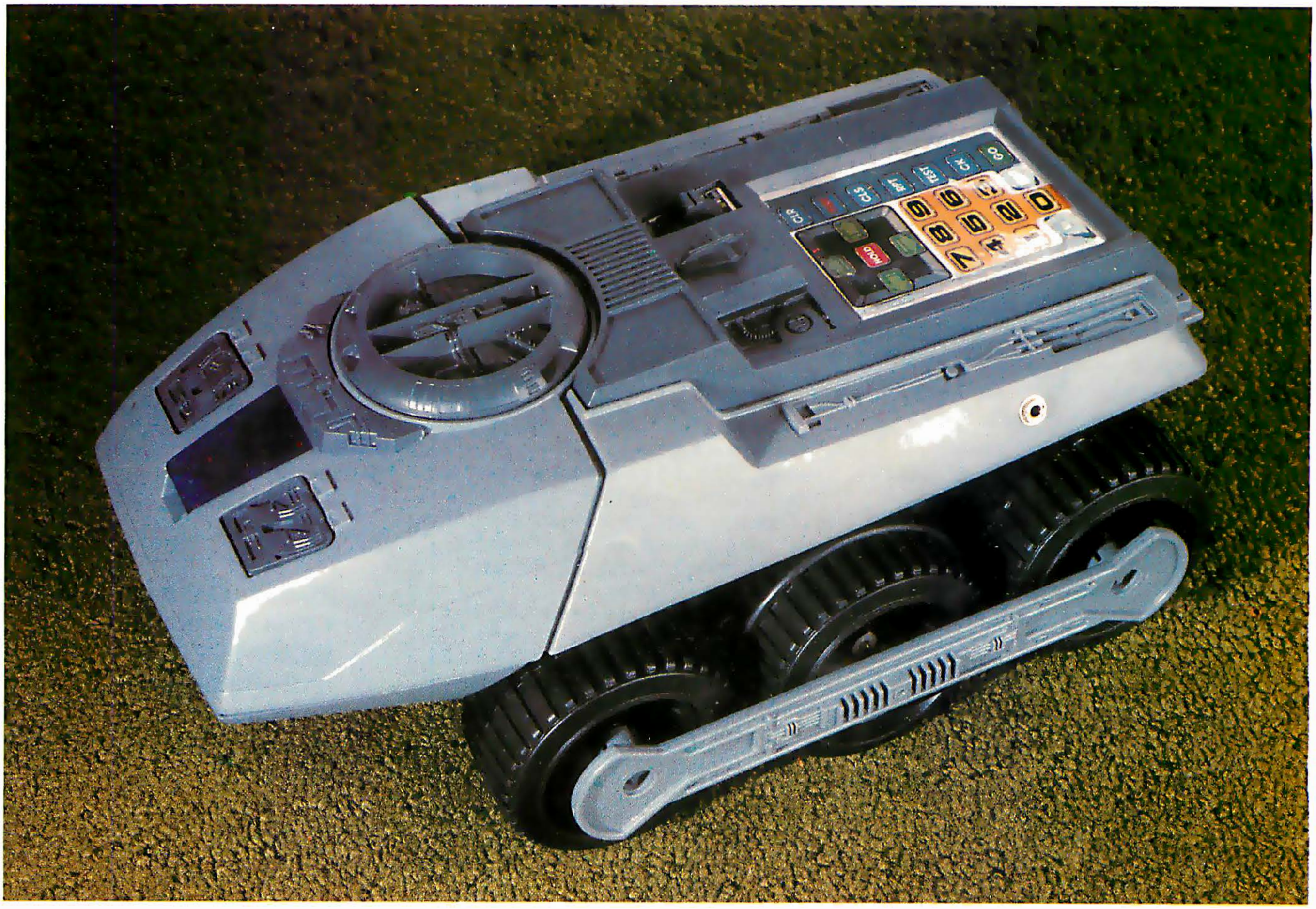


Photo 1: *The Big Trak microprocessor-controlled, user-programmable tank, sold by the Milton-Bradley Company.*

quence is four commands. Big Trak can hold sixteen commands.

Considering this month's Circuit Cellar title and the description thus far, you may think this article is about Big Trak and the microcomputer control system it employs. You are half right. Big Trak is indeed the tank mentioned in the title. However, the word "Computer" in "Computer-Controlled Tank" refers to *your* personal computer, rather than the microprocessor inside the tank!

For a long time I have been interested in robotics. I have always fantasized about building a robot to do simple tasks. I am sure that many others have similar interests. Unfortunately, due to the high expense and the mechanical expertise required, most of us never get beyond the idea stage.

Playing with Big Trak is a tease. It is not a robot, nor can it be converted into one. However, it has features that are fascinating as well as aggravating for robot-building procrastinators like myself. Big Trak has a control system that memorizes commands and coordinates a mechanical drive. It converts simple keystrokes into complex movements combined with light and sound effects.

While the microprocessor program that controls the tank is interesting, it is the price/performance ratio of the mechanism that is impressive. Big Trak incorporates a two-wheel/two-motor gearbox. The wheels turn synchronously for forward or backward motion and contrariwise for turns. Left and right turns are precisely definable (to a resolution of 1 part in 60). This drive mechanism would take many hours to fabricate if you were building it from scratch.

For die-hard robotics types, this is kid stuff. EXACTLY! But, to someone with just a passing interest, the capabilities of this $50 toy are fascinating. With a little ingenuity, it could serve as a test bed for robot enthusiasts on a tight budget. It could also serve as a school project combining programming and actual control of a mechanical device.

If only it could be linked with a larger computer and remotely controlled!

This idea sounded like a fun project, so I decided to write an article on converting Big Trak to remote control. The result is an interface that allows complete wireless control of the tank's operation from your computer keyboard. Virtually no modification is required to your computer if it already incorporates a serial I/O (input/output) port and 300 bps (bits per second) modem.

Writing the control program isn't hard. Commands are communicated as LPRINT CHR$(X) statements in BASIC. (For example, an LPRINT CHR$(81) fires the photon cannon.) A program which demonstrates this is included. (See listing 1.)

At the other end of the link, a circuit is installed in the tank to receive control commands from your computer and simulate the user pressing the keypad. This is not a specialized interface applicable only to Big Trak; the receiver has useful applications elsewhere. It is designed in two sections: a tank interface specifically for this application and a general-use wireless receiver/demodulator. The receiver/demodulator can easily serve as a wireless serial RS-232C extension for your computer in other applications. Don't care to string wires for a printer located in another room? Use this receiver interface up to 200 yards from the computer.

All this will be explained in detail, but first, back to Big Trak.

Inside Big Trak

Big Trak gets its control capability from a TI (Texas Instruments) TMS1000-series 4-bit microprocessor. This single 28-pin CMOS (complementary metal-oxide semiconductor) integrated circuit contains programmable user memory, ROM

Single Entry:			
	Test	— Tests tank operation by moving and firing cannon	
	Clr	— Erase all previous command entries	
	Cls	— Erase last entry only	
	Ck	— Execute last command entry immediately	
	Go	— Execute complete command sequence	
Multiple Entry:			
	Backward/Forward	— How far?	Enter 1 to 99 feet.
	Turn (Left/Right)	— How much?	Enter 2-digit turn value.
	Fire	— How many shots?	Enter 1 to 99 shots.
	Hold	— How long?	Enter 0.1 to 9.9 seconds.
	Repeat	— How many steps back?	Enter 1 to 15.

Table 1: *Summary of commands as entered on Big Trak's keypad. Some commands are completed with a single keystroke, while other commands require multiple keystrokes (to enter qualifying data, such as how far to travel). The actual Big Trak keypad is shown in photo 3.*

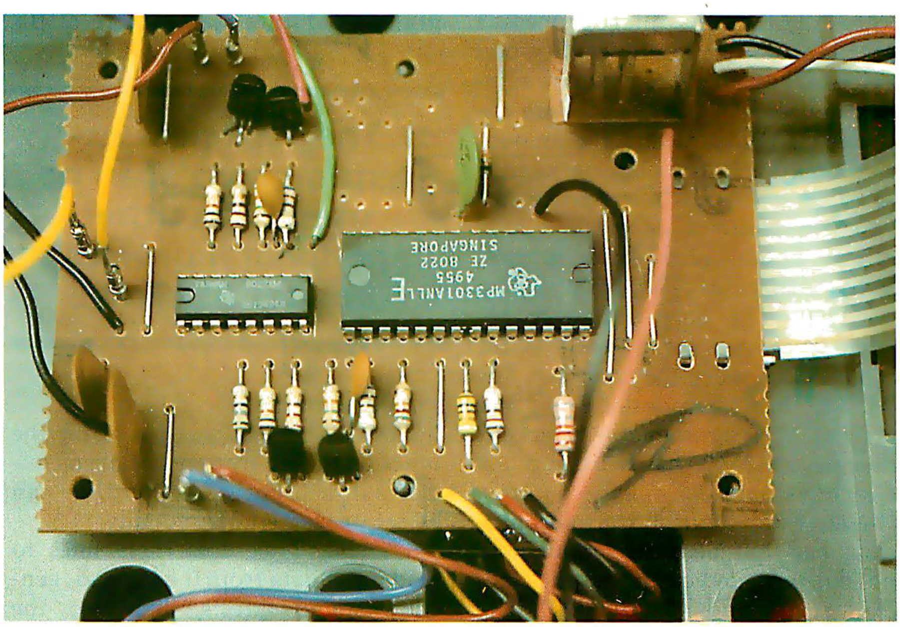


Photo 2: *The microprocessor control system inside Big Trak. The 28-pin integrated circuit is a TI TMS1000-series 4-bit microprocessor. The smaller package is a hex digit driver used in this application to power the various tank functions.*

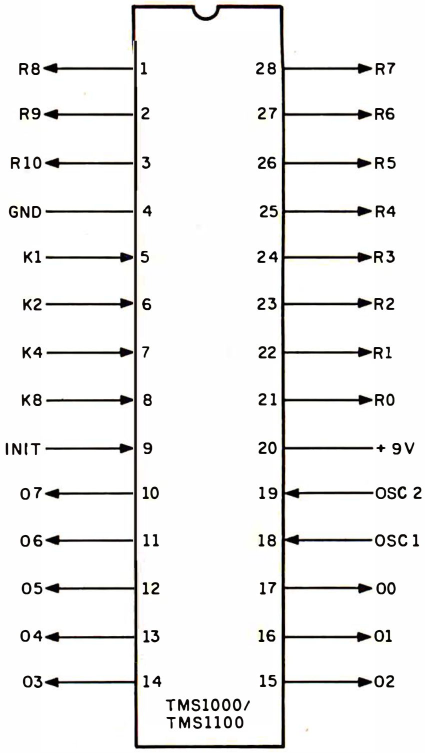


Figure 1: *Pin usage of the TI TMS1000 4-bit microprocessor. The TMS1000-series processors all have the same instruction set, differing in the number of pins used for I/O and in the amount of memory contained in the package.*

Pin Name	Description	Type
K1,K2,K3,K4	data input	input
O0 thru O7	data output	limited code output
R0 thru R10	control output	output
OSC1, OSC2	timing	input (resistor/capacitor)
INIT	power-on reset	input

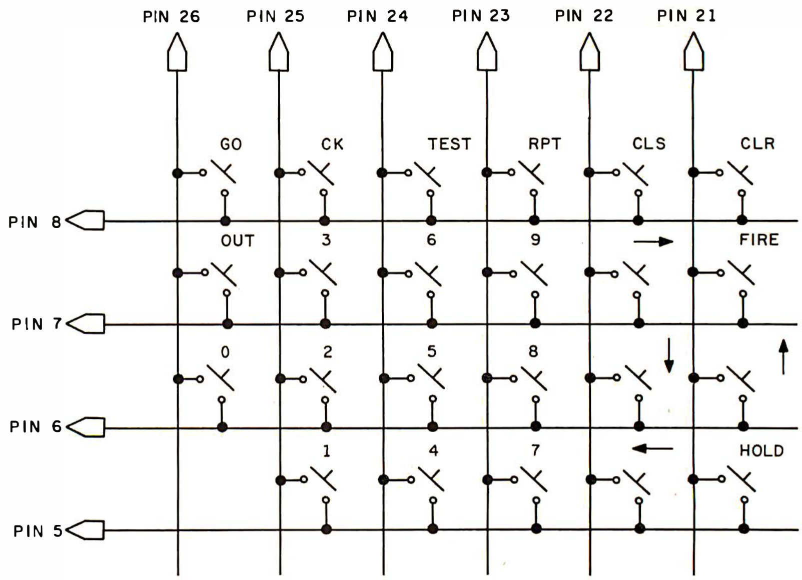


Figure 2: *Schematic diagram of the Big Trak's keypad matrix. The column lines are connected to the R-series output pins on the TMS1000, and the row lines are connected to the K-series input pins. The physical structure of the keypad can be seen in photo 4.*

(read-only memory), and I/O capability. The low cost (under $1 in large quantities) makes this the product of choice for many simple applications such as computer games and appliance controls.

The TMS1000 microprocessor series is actually a family of fifty-odd devices. They all share a common instruction set. The differences are the number of I/O pins and the amount of on-board memory. The package of Big Trak's 28-pin microprocessor, shown in photo 2, is marked only with a "house" number. It is most likely either a TMS1000 or a TMS1100. The only difference between these two components is the amount of memory they contain. The TMS1000 has 1 K bytes of ROM and 32 bytes of programmable memory, while the TMS1100 has twice as much of each memory.

As shown in figure 1, the microprocessor has four dedicated input lines and nineteen dedicated output lines (O0 thru O7 and R0 thru R10). The eight data outputs, O0 thru O7, are wired in an unusual way and can be set to only 32 out of the usual 256 values possible with an 8-bit code. This is because the O-series outputs receive only the 4-bit values from the accumulator and the status flag (1 bit) as inputs. The enabled range of the 32 values (out of the 256) is mask-programmed during manufacture of the circuitry on the silicon chip.

The "wireless extension cord" can be used with other peripheral devices besides Big Trak.

The R-series output lines, on the other hand, are treated as eleven control outputs. Each R output line can be set or cleared individually.

The Big Trak uses these lines to read input data from the keypad, generate sound effects, light up the "photon cannon," and coordinate the operation of the two motors.

Because the TMS1000 is a low-power device (about 90 mW), it cannot directly drive a motor. A second integrated circuit (an SN75494) and a few transistors facilitate the connection. The 75494 is a hex digit driver primarily intended to interface CMOS devices to common-cathode-configured LEDs (light-emitting diodes). While the tank uses no LEDs, the 150 mA drive-current capability of the 75494 makes it particularly suitable in this application.

Connection of the keypad (shown in photo 3) to the microprocessor is straightforward. The keypad is actually a matrix of processor I/O lines. Outputs R0 thru R5 and inputs K1, K2, K4, and K8 form a 4 by 6 matrix (only twenty-three keys are functional—the In key has no contacts) as shown in figure 2. The K signals are the rows, and the R signals are the columns.

Such a keypad operates on a scanned-matrix principle. The processor alternately places a signal on each R line and reads the four inputs for any completed circuit (which shows a key being pressed). Entering a command, therefore, is simply a

The Big Trak can serve as a test bed for robot enthusiasts on a tight budget.

process of shorting one of the cross points of the matrix.

The keypad has no springs, magnets, or raised buttons. It is nothing more than two photo-etched plastic sheets with conductive traces, separated by a thin insulator. At the cross points of the matrix, the insulator has a cutout. Any pressure on the keypad surface over this point flexes the plastic and shorts the two contacts, completing the circuit. Photo 4 shows the structure of the keypad.

Practically speaking, *any* connection between a column and a row of the matrix will be perceived as a valid data input to the processor. For example, if you use a clip lead to connect pins 8 and 26 on the processor package, it will accept this as a Go command and commence operation. This concept is the premise of my remote-control circuit.



Photo 3: *Commands are entered into Big Trak's memory through this keypad on the top of the tank.*

External Keyboard Control

Remote control of Big Trak starts with an interface that attaches to the processor and functions in place of the keypad. Figure 3 shows the schematic diagram of a circuit that does this. The prototype is shown installed over the processor board in the tank. (See photo 5.) Its location with respect to the tank layout is better shown in photo 6.

The integrated circuits IC2 and IC3 are 8-channel type-CD4051 CMOS multiplexers. The 6 matrix column lines are attached to IC2, and the 4 row lines are connected to IC3. The selection of 1 of the 6 column lines and 1 of the 4 row lines is determined by the address-input lines A, B, and C on each integrated circuit. A total of 5 address bits are required. While a six-conductor cable (5 bits of data and ground) strung between the computer and the tank for parallel communications would work, it is hardly efficient as remote control. Serial communication is better, for a number of reasons.

The components IC1, IC4, and IC5 function as a 300 bps serial-to-parallel converter which operates on 9 V (note the use of the General Instrument AY-3-1014A UART, a universal asynchronous receiver/transmitter). Data comes into pin 20 of IC3 at 300 bps where it is reconverted to parallel format. Bits 0 thru 2 (D0 thru D2) go to IC2, and bits 4 and 5 (D4 and D5) go to IC3. The choice is not arbitrary.

By selecting these particular bits as the address inputs, the CMOS switches can be set by binary codes that correspond to ASCII (American Standard Code for Information Interchange) characters. This makes the interface more flexible, since its functions can be exercised directly through characters output by use of the CHR$(X) function in the BASIC language. The necessary codes are common, printable characters and will not interfere with machine operation. (In some BASICs, the CHR$(X) function can cause strange things to occur, depending upon the value of X. In my computer system, sending a CHR$(127) clears the screen and resets the cursor.) Choosing printable codes also aids troubleshooting. Table 2 lists the twenty-three codes

used in this interface. For example, sending an "R" (with the output statement LPRINT CHR$(82)) tells the tank to make a right turn.

Oscillator IC5 (a 555 timer) is tuned for 4800 Hz. This sets the communication data rate at 300 bps. A rate of 110 bps is set by changing the oscillator frequency to 1760 Hz.

Operation is straightforward. The UART is hard-wired for 8 bits of data, no parity bit, and 1 stop bit. When a character is received, the data-output line becomes active and the DAV (data available) line goes high. One section of IC4 serves to delay the reset pulse to the $\overline{\text{RDAV}}$ (reset data available) input. This produces a 10 ms strobe signal which closes the CMOS switches. (While the data rate may be 300 bps, time must be allotted between characters to allow the tank control system to respond. The effective data rate is more like five commands per second.) Whatever points were addressed on IC2 and IC3 will be electrically connected. The tank will then either store or execute the command, depending upon what it is.

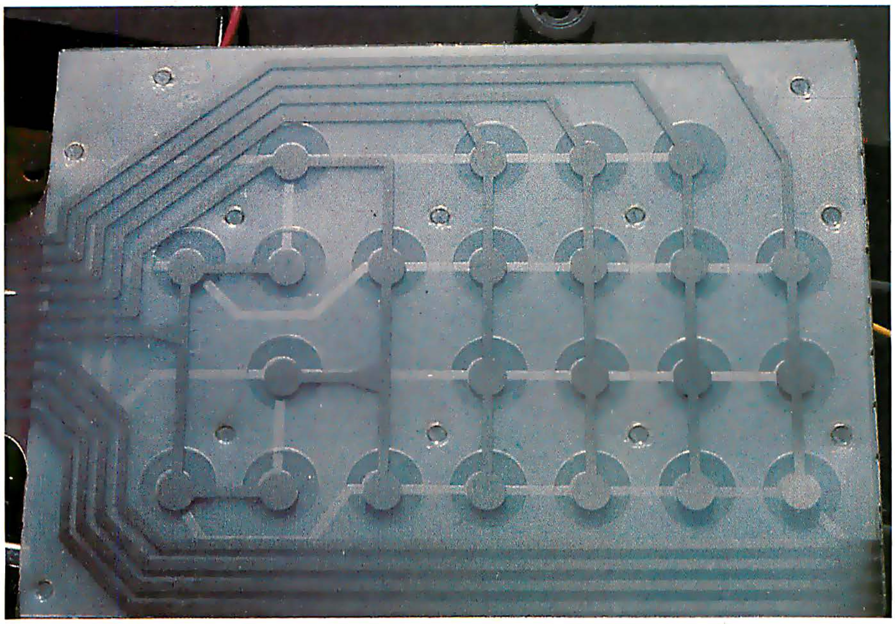


Photo 4: *A rear view of the keypad, showing its construction. The keypad consists of two plastic sheets containing photo-etched conductors separated by a layer of insulation. At the locations of the function keys, the insulation has a circular cutout through which the two conductive layers can touch when pressure is applied.*

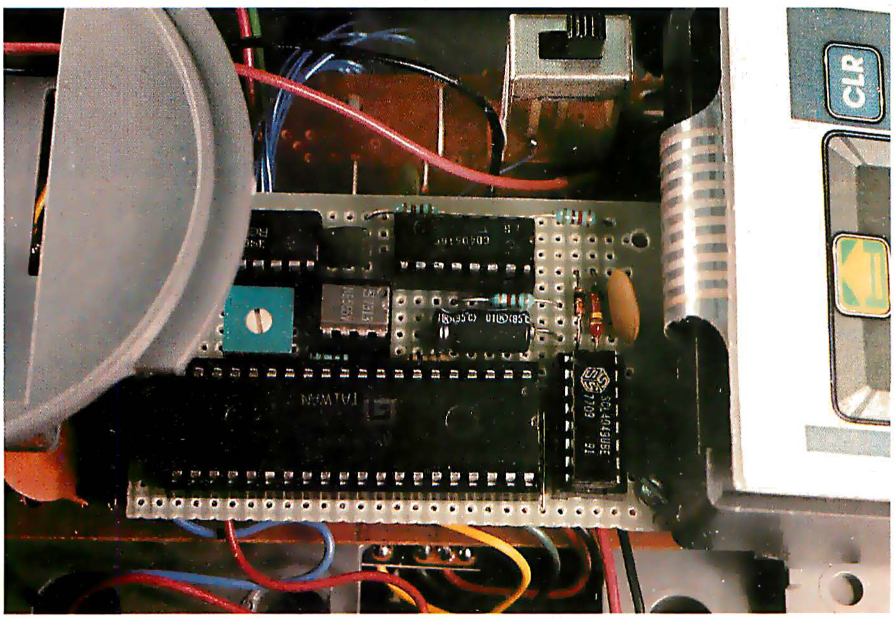


Photo 5: *The prototype of the Big Trak control interface of figure 3. It is mounted on top of the tank's processor board and is powered by the tank's 9 V battery. The interface contains a 300 bps serial-to-parallel converter which directs the operation of the CMOS switches attached across the keypad matrix.*

Functionally speaking, you could stop right now. If you don't mind a two-wire cord running from your computer to the tank, you can control it with just the circuit so far described. Simply set your serial output port at 300 bps and feed its signals directly to pin 9 of IC4 in the interface. This, in fact, was the way I had to test the circuit before I went on to the next step.

Constructing a "Wireless Extension Cord"

The next step is, of course, the real fun part of this project. Since we can now command the tank through serial-character transmissions, it is only natural to consider eliminating the wire and using wireless communication.

Let's take stock. We have a tank that for all practical purposes is remote-controlled. All we have to do is send TTL (transistor-transistor logic)- or CMOS-level serial characters to it. These characters, in turn, come from BASIC LPRINT CHR$(X) statements, the output of which is transmitted serially. On the computer side, we have a serial output, and on the tank side we have a serial input. Connecting the two requires an "extension cord," either physical or ethereal.

One method, shown in the block diagram of figure 4, uses radio transmission. The approach is not as strange as it might initially seem. The serial output from your computer is FSK (frequency-shift keyed) modulated and transmitted. Somewhere at a remote location, a receiver picks up this transmission and demodulates it. The reconstructed serial data is fed into the remote device, in our case, the Big Trak control interface.

Please note the following: because this interface uses standard serial-data rates and voltage levels, any wireless communication device we design to accommodate computer/Big Trak communication will also work for any other similar-rate communication. The computer doesn't know whether it is "talking" to a tank

Number	Type	+9 V	GND
IC1	AY-3-1014A	1	3
IC2	CD4051	16	7,8
IC3	CD4051	16	7,8
IC4	CD4049	1	8
IC5	NE555	8	1

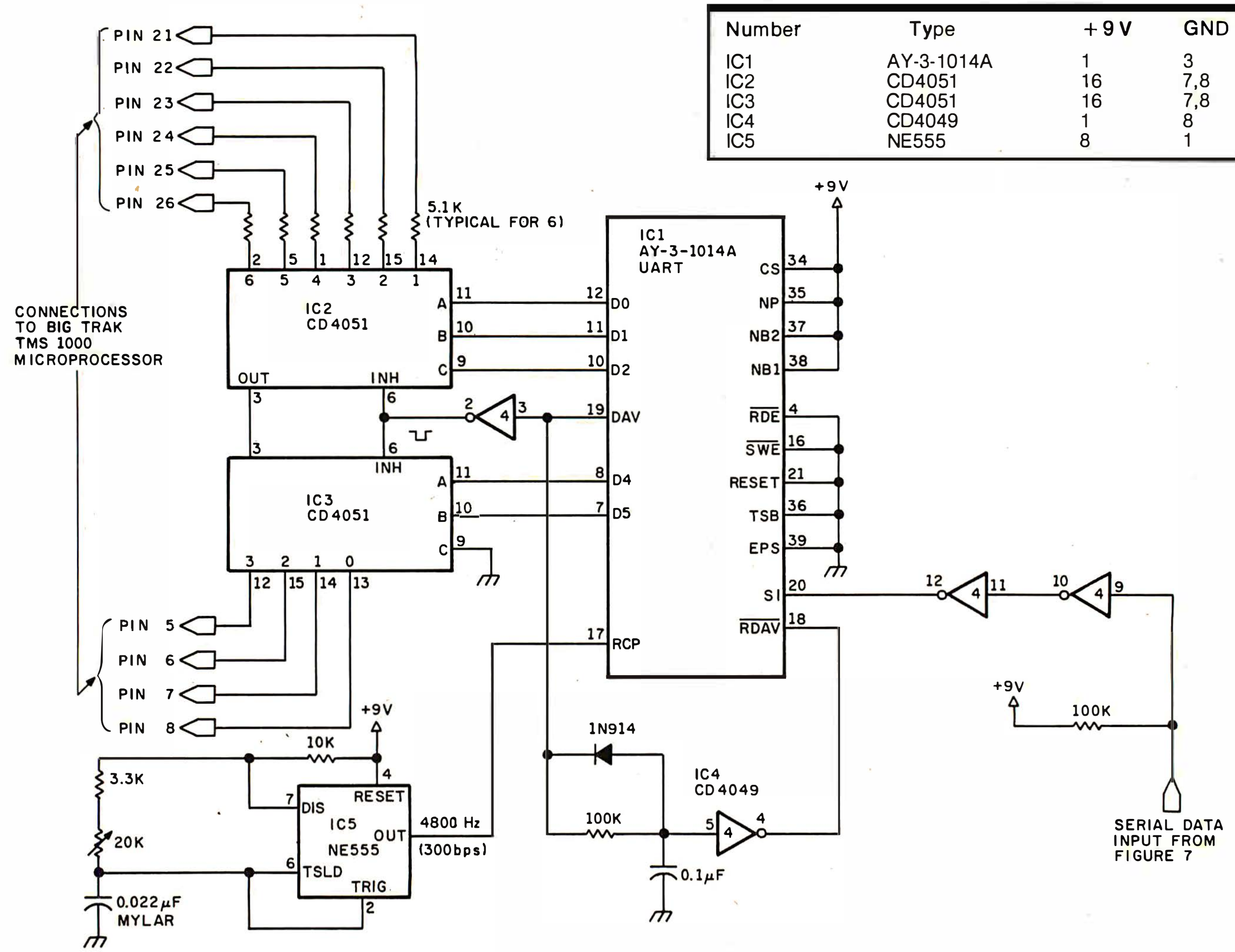


Figure 3: *Schematic diagram of the Big Trak remote-control interface. This circuit is installed inside the tank, replacing the function of the manual keypad. The address-input lines on each of the two CD4051 8-channel multiplexers select the rows and columns of the keypad matrix.*

The AY-3-1014A UART is a product of General Instrument Corporation, Microelectronics Division, 600 W John St, Hicksville NY 11802.

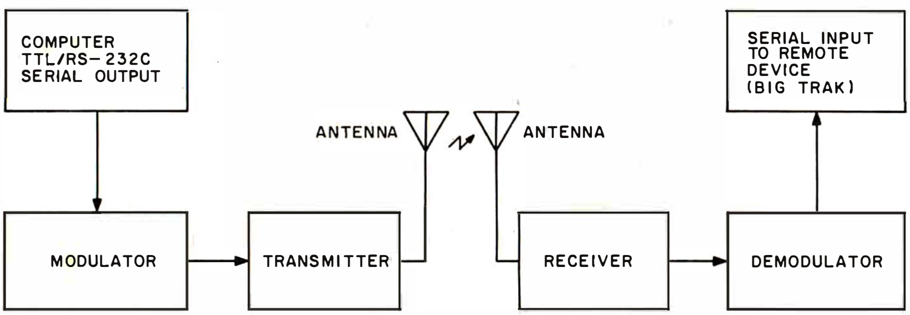


Figure 4: *Conceptual block diagram of a typical wireless communications link.*

or to a remote printer. The "wireless extension cord" depicted in figure 5 can just as easily be attached between the computer and any output peripheral device.

Figure 5 outlines a simple way to accomplish this communication. At the computer, an FSK modulator converts the 1 and 0 levels to 2025 Hz and 2225 Hz tones. These tones are transmitted using an inexpensive 49.86 MHz walkie-talkie. At the receiving end (in this case, the Big Trak), another walkie-talkie receives the tones and a demodulator reconverts the tones to logic levels which are fed to the UART/control interface.

Figure 6 is a schematic diagram of an answer-type modem modulator. The assembled circuit is shown in photo 7. Serial data from the computer is fed into pin 1 of IC2, as shown. A logic 1 input produces a 2225 Hz tone, and a logic 0 input produces a 2025 Hz tone. These tones are amplified by IC3 and are directly fed to the walkie-talkie transmitter, through a connection across its speaker.

Figure 7 is a diagram of the circuit required at the receiving end. It consists of an originate-type modem demodulator and a walkie-talkie receiver. The guts of the walkie-talkie are removed from its case and mounted in the same enclosure with

the modem board. Photo 9 shows the receiver mounted in the bottom of the box. The modem board is mounted on stand-offs over the receiver, and batteries are placed along the edge and under the board, as shown in photo 10.

The audio output of the walkie-talkie is tapped from speaker leads; a 10-ohm resistor should be substituted for the speaker if you don't wish to hear the tones. This audio signal is connected to the modem preamplifier input. It is next sent through a band-pass filter and limiter, which maximizes the signal level yet keeps it under the saturation point of the demodulator. The demodulator, IC3, is an XR2211 monolithic PLL (phase-locked loop). It is set to work at 2025 and 2225 Hz. The output of the demodulator is a logic signal that is compatible with the UART in the tank controller.

The basic circuits shown in figure 6 and 7 were originally presented in the Circuit Cellar article titled "A Build-It-Yourself Modem for Under $50" (BYTE, August 1980, page 22). I refer you to that article for a more complete explanation of modem communication. (See also "BYTE's Bugs," BYTE, October 1980, page 332, and November 1980, page 112.)

Wireless remote control in an automated-house application was discussed in "Handheld Remote Control for Your Computerized Home," BYTE, July 1980, page 22.

The printed-circuit boards shown in photos 7 and 10 are the production modem boards originally offered as a kit with components for those people interested in constructing their own modems from the August article. These circuit boards are still available and were used to construct the interface described in this article. A text box at the end of this article tells how to order one of these boards.

The completed interface is a fairly neat package. While it is large in comparison to the five-integrated-circuit assembly inside the tank, it can still be toted along behind Big Trak by using the Big Trak Transport, the tank's cargo trailer. A cable and jack connect the receiver to the controller in-

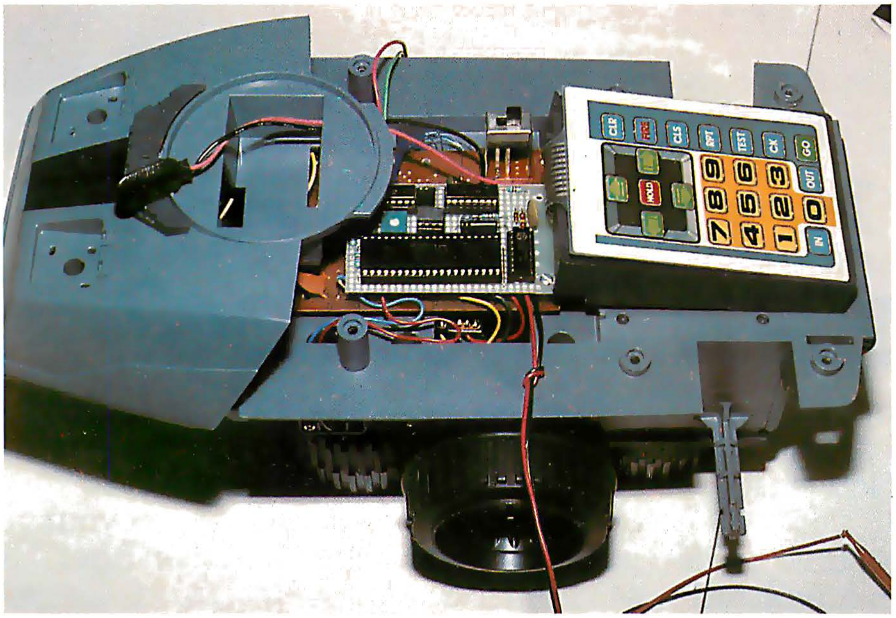


Photo 6: *Big Trak undergoing modification. The interface circuit of figure 3 may be seen inside, in front of the keypad.*

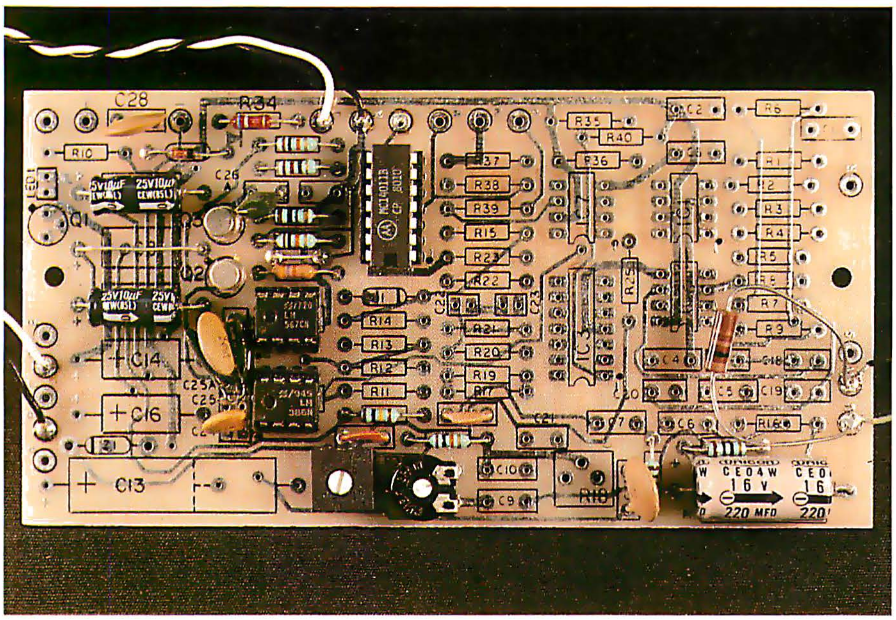


Photo 7: *The modulator section of an answer-type modem. The serial data output from the computer is modulated according to an FSK scheme into audio tones with frequencies of 2025 and 2225 Hz.*



Photo 8: *The output of the modem modulator is connected by a cable to this walkie-talkie (a Radio Shack number 60-4001) for transmission to the receiver on the Big Trak. The connection to the transmitter section of the walkie-talkie is made across the speaker terminals, with a 10-ohm resistor inserted in the circuit in place of the speaker. A phono jack installed on the front of the walkie-talkie facilitates the connection.*

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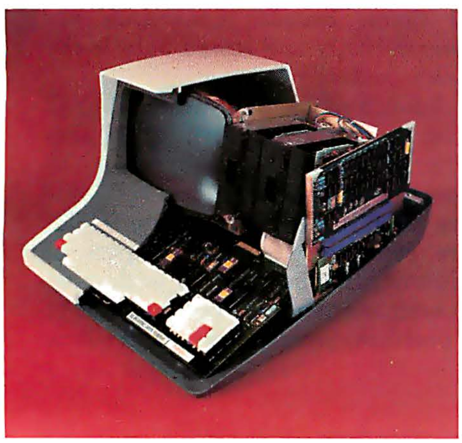
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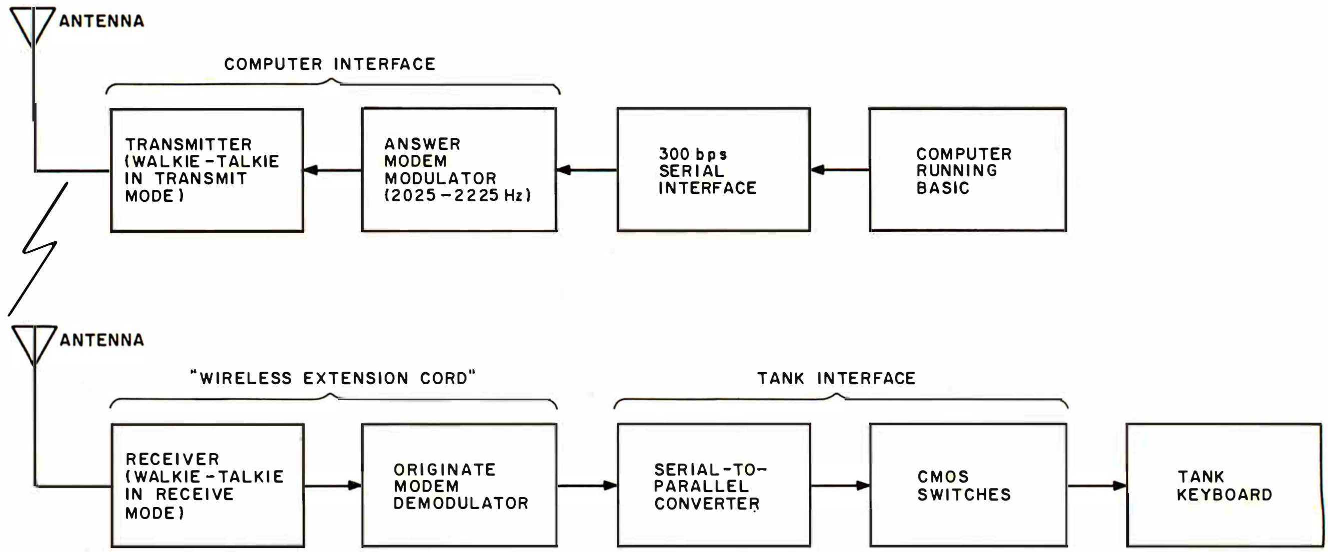
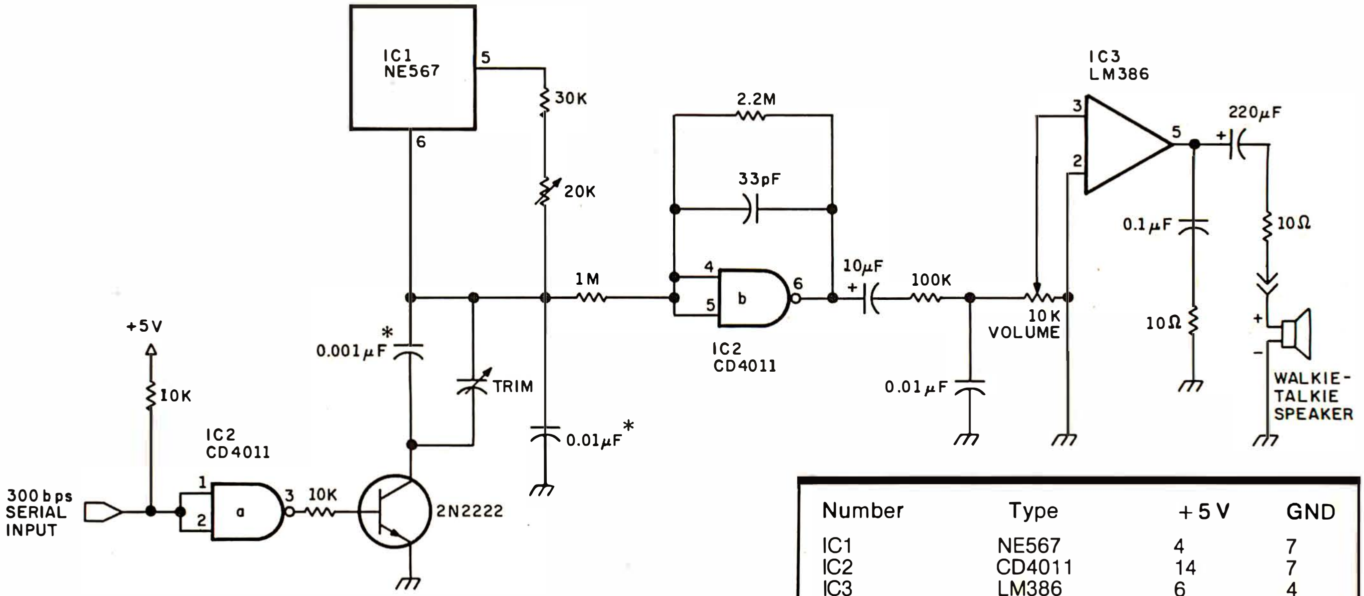


Figure 5: *Block diagram of the wireless remote-control system described in this article. FSK modulation is employed along with inexpensive walkie-talkies to create a "wireless extension cord."*



Number	Type	+5 V	GND
IC1	NE567	4	7
IC2	CD4011	14	7
IC3	LM386	6	4

Figure 6: *Schematic diagram of the modulator section of an answer-type modem. The assembled circuit is shown in photo 7. In this FSK-modulation scheme, a logic 1 input produces an output frequency of 2225 Hz, while a logic 0 produces an output frequency of 2025 Hz. The output is connected across the speaker (which also serves as a microphone) in the walkie-talkie, which is connected to the transmitter section. Capacitors marked with an asterisk (*) should be Mylar type parts.*

terface. The combination tank/trailer is shown in photo 11.

Programming Big Trak from Your Computer Keyboard

Now that you have a remote-controlled tank, you have to write a suitable control program. The complexity of the program depends upon the level of sophistication you desire. The interface was designed for simple interaction, and it doesn't require much. Complete direction can be accomplished with as little as the following BASIC program:

```
100 INPUT A
110 LPRINT CHR$(A);
120 GOTO 100
```

In this program, the value of the variable A should be one of the 23 decimal values listed in table 2. The operator must keep track of the entry sequence, and Big Trak and the communication link must be powered at all times, because commands are entered singly and stored only in the tank's control system.

A much more sophisticated BASIC program is shown in listing 1. This program allows the operator to assemble a command sequence off-line with functional entries (Hold, Fire, etc) rather than coded inputs. In addition, the time needed to develop a command sequence becomes less of a problem, since power to the tank

Text continued on page 58

Listing 1: *A program in BASIC that allows the operator to assemble a Big Trak command sequence using functional entries. The command sequence is stored within the host computer and is transmitted in its entirety to the Big Trak when the operator gives the Go command.*

```
100 REM ************ BIG TRAK  REMOTE CONTROL PROGRAM **********
110 REM
120 REM
130 REM
140 REM Clear enough memory space for possible 16 command sequence
150 FOR Q=25000 TO 25048 :POKE Q,0 :NEXT Q :REM Clear Memory Table
160 REM
170 REM Load conversion table for ASCII 0-9 to tank code
180 DATA 38,53,37,85,52,36,84,51,35,83
190 FOR W=0 TO 9: READ B(W): NEXT W
200 REM
210 REM
220 PRINT:PRINT:PRINT:PRINT"COMPUTERIZED REMOTE CONTROL":PRINT
230 K=0 :REM Reset Command Counter
240 S=0:T=25000: POKE T,65: T=T+1 :REM Set first code in table
250 REM it clear code
260 PRINT"Command list to be repeated each time (Y or N)";:INPUT C$
270 IF C$="Y" THEN C=1 ELSE C=0 :GOSUB 990 :GOTO 300
280 REM
290 REM
300 IF C=1 THEN GOSUB 990 ELSE GOTO 310
310 PRINT:PRINT"Command";:INPUT A$
320 IF A$="M" THEN GOTO 440
330 IF A$="C" THEN GOTO 600
340 IF A$="H" THEN GOTO 650
350 IF A$="R" THEN GOTO 720
360 IF A$="T" THEN GOTO 760
370 IF A$="F" THEN GOTO 820
380 IF A$="D" THEN GOTO 890
390 IF A$="G" THEN GOTO 920
400 IF A$="L" THEN GOTO 1290
410 GOTO 310
420 REM
430 REM ------- Move Command --------
440 PRINT"(F)orward,(B)ackward,(L)eft,or (R)ight":INPUT B$
450 IF B$="F" THEN X=33 :GOTO 500
460 IF B$="B" THEN X=34 :GOTO 500
470 IF B$="L" THEN X=50 :GOTO 550
480 IF B$="R" THEN X=82 :GOTO 550
490 GOTO 300
500 PRINT"How many feet (1 to 99)";:INPUT Q1
510 IF Q1<=0 THEN 500
520 IF Q1>99 THEN 500
530 GOSUB 980
540 GOSUB 1090: GOTO 300
550 PRINT"Turn how many degrees (0 to 360)";:INPUT Q1 :Q1=INT((Q1/360)*60)
560 GOSUB 980
570 GOSUB 1090 :GOTO 300
580 REM
590 REM ------- Clear Command --------
600 K=0 :S=0 :T=25000 :FOR Q=25000 TO 25048 :POKE Q,0 :NEXT Q
610 PRINT"Stored sequence cleared --- Start Again":POKE T,65 :T=T+1
620 GOSUB 990 :GOTO 310
630 REM
640 REM ------- Hold Command ---------
650 X=49 :PRINT"Hold how many seconds (total times .1sec)";:INPUT Q1
660 IF Q1<=0 THEN 650
670 IF Q1>99 THEN 650
680 GOSUB 980
690 GOSUB 1090 :GOTO 300
700 REM
710 REM ------- Repeat Command --------
720 X=67 :PRINT"Repeat how many steps";:INPUT Q1 :GOSUB 980
730 GOSUB 1090 : GOTO 300
740 REM
750 REM ------- Test Command --------
760 IF T<=25001 THEN 770 ELSE 790
770 LPRINT CHR$(68);:PRINT"TEST COMMAND TRANSMITTED"
780 GOSUB 990 :GOTO 310
790 PRINT:PRINT"CAN NOT EXECUTE EXCEPT AS FIRST COMMAND" :GOTO 300
800 REM
810 REM -------- Fire Command --------
820 X=81 :PRINT"How many shots (1 to 99)";:INPUT Q1
830 IF Q1<=0 THEN 820
840 IF Q1>99 THEN 820
850 GOSUB 980
860 GOSUB 1090 :GOTO 300
870 REM
880 REM -------- Dump (OUT) Command --------
890 X=86 :GOSUB 1090 :GOTO 300
900 REM
910 REM -------- Command Transmitter --------
920 X=70 :PRINT"COMMAND CONTROL SEQUENCE IS BEING TRANSMITTED TO TANK"
930 PRINT :PRINT
940 GOSUB 1200
```

Listing 1 continued on page 58

And now for the per

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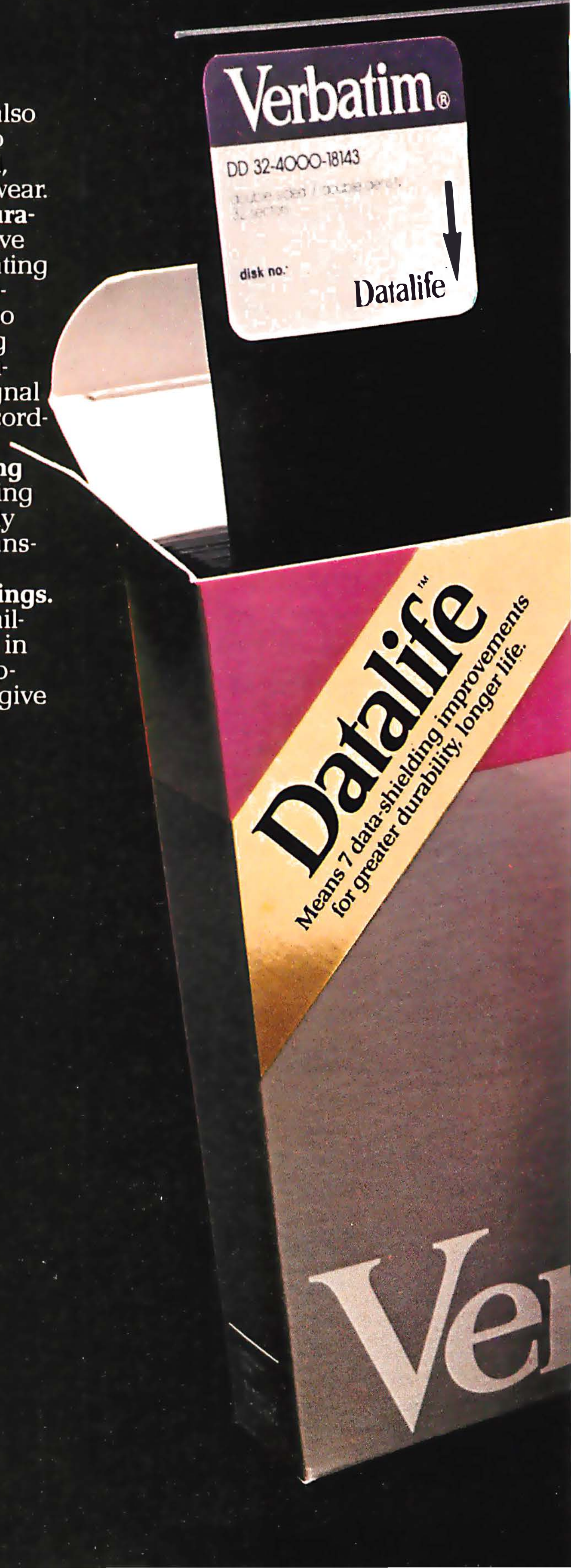
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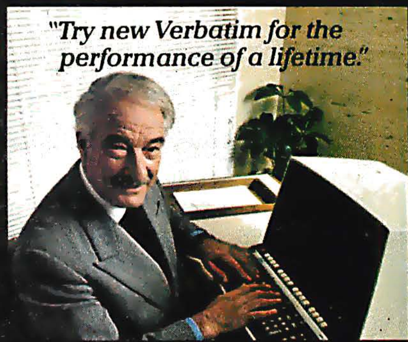


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Listing 1 continued:

```
950 PRINT:PRINT"Retransmit Same Control Sequence (Y or N)",:INPUT Q$
960 IF Q$="Y" THEN LPRINT CHR$(70);: GOTO 920
970 IF Q$="N" THEN 220 ELSE 950
980 A1=INT(Q1/10) :A=Q1-A1*10 :RETURN
990 REM
1000 PRINT"                  COMMANDS :"
1010 PRINT"      (M)ove                    (F)ire"
1020 PRINT"      (C)lear                   (D)ump"
1030 PRINT"      (H)old                    (G)o"
1040 PRINT"      (R)epeat                  (D)ump"
1050 IF T<=25001 THEN PRINT"      (T)est"
1060 RETURN
1070 REM
1080 REM Store Command Code in Memory Table
1090 POKE T,X :T=T+1:K=K+1
1100 IF A+A1=0 THEN RETURN
1110 IF A1=0 THEN 1130
1120 POKE T,B(A1) :T=T+1
1130 POKE T,B(A) :T=T+1
1140 PRINT"                             Command Stored";
1150 IF K>=15 THEN GOTO 1160 ELSE 1170
1160 PRINT :PRINT"NEXT COMMAND MUST BE GO !" :RETURN
1170 RETURN
1180 REM
1190 REM LPRINT Command Sequence from Memory Table
1200 POKE T,X
1210 FOR E=25000 TO T
1220 D1=PEEK(E) :LPRINT CHR$(D1);
1230 FOR C=0 TO 100: NEXT C
1240 NEXT E
1250 PRINT"TRANSMISSION COMPLETE"
1260 RETURN
1270 REM
1280 REM Display codes stored in memory table
1290 FOR N=25000 TO 25048 :PRINT PEEK(N);" ";:NEXT N
1300 GOTO 300
```

Command Name	ASCII Character	Hexadecimal Code	Decimal Code
Forward	!	21	33
Backward	"	22	34
Right	R	52	82
Left	2	32	50
Clear (all)	A	41	65
Clear (last)	B	42	66
Hold	1	31	49
Repeat	C	43	67
Check	E	45	69
Fire	Q	51	81
Out	V	56	86
Test	D	44	68
Go	F	46	70
0	&	26	38
1	5	35	53
2	%	25	37
3	U	55	85
4	4	34	52
5	$	24	36
6	T	54	84
7	3	33	51
8	#	23	35
9	S	53	83

Table 2: *Correspondence of ASCII characters to the twenty-three Big Trak command codes. The decimal values of the ASCII characters are sent to the transmitter using the BASIC statement LPRINT CHR$(X).*

Text continued from page 54:

and communication interface need to be turned on only when the sequence is to be executed. The Go command transmits the entire repertoire to the tank in one stream of data.

The data sent to the tank can in fact be seen in the sample run of listing 2. I used the same serial port designated for the wireless communications link to list the program. You'll note the string of extraneous characters after "COMMAND SEQUENCE IS BEING TRANSMITTED TO TANK". "A!%1%&Q$25$15&QTC%F" is the string sent to the tank by the CHR$(X) function. It ended up on the listing (inadvertently) because both devices (printer and tank) use the same I/O-port address. If you compare these characters to those in table 2, you will see that it represents the

commands entered during execution of the program.

The program here, of course, is designed more as a demonstration than as a functional illustration of computer intelligence. I don't play with these interfaces every day, and it is easy for me to forget the steps necessary to enter a program on the keypad. By making it as idiot-proof as possible, by prompting the correct response, *I* can appear more intelligent when I demonstrate Big Trak.

In Conclusion

Big Trak will not create any earth-shaking movement within the robot-

Text continued on page 64

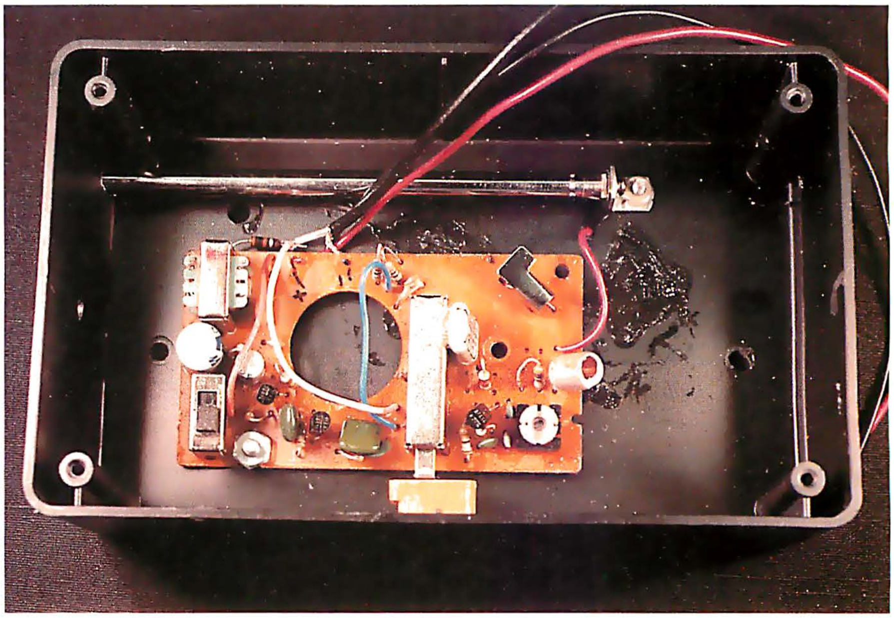


Photo 9: *A second walkie-talkie is used in the receiving section of the remote-control hardware. The working parts of the walkie-talkie have been placed in the same enclosure that will shortly house the demodulator circuit. Here again, the speaker has been removed from the walkie-talkie and a 10-ohm resistor substituted.*

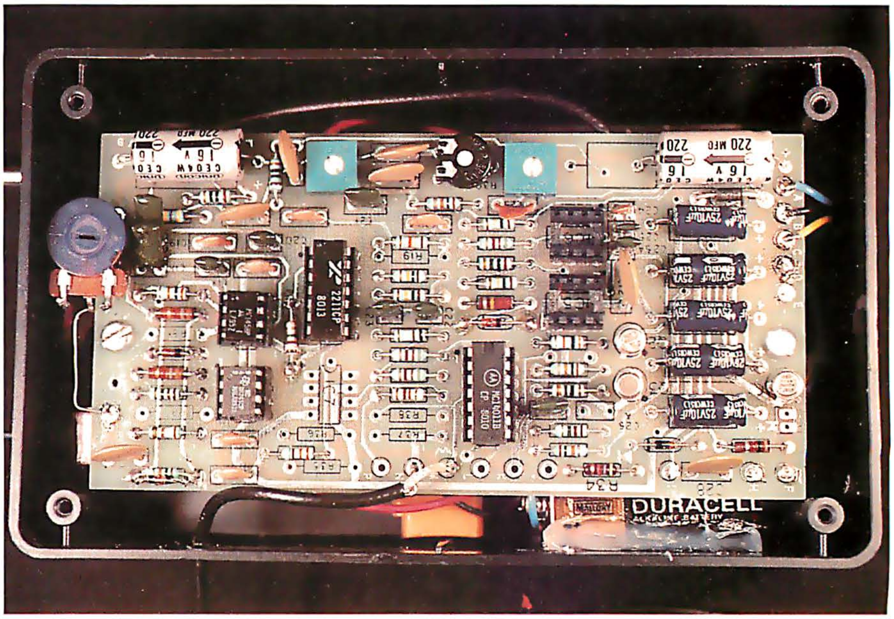
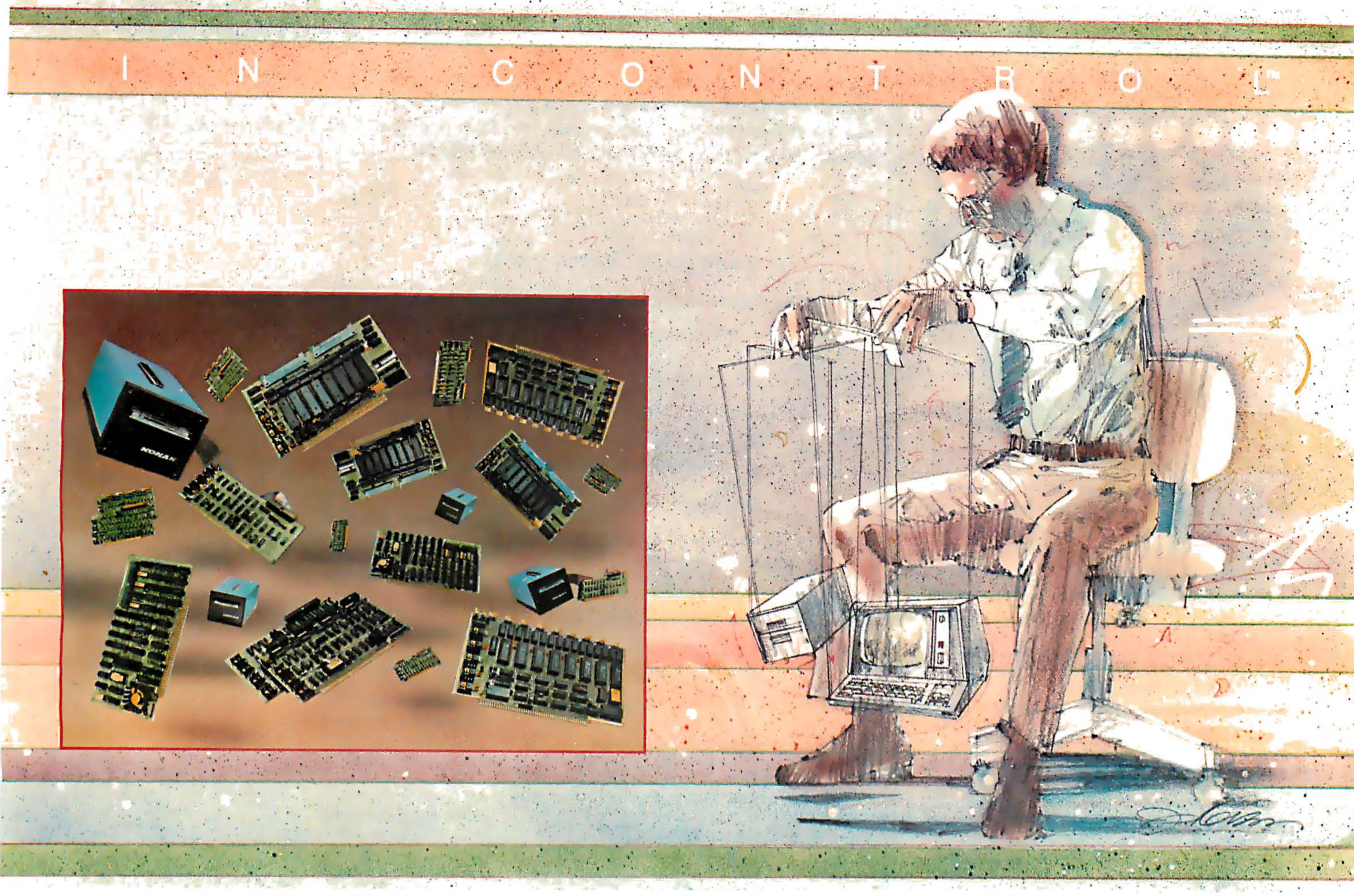


Photo 10: *The originate-type modem demodulator of figure 7 has been constructed on a printed-circuit board and placed in this box over the walkie-talkie circuit. The modulator section of the circuit board is not used in this application; therefore the integrated circuits used only by the modulator have been removed. The circuit board is mounted on stand-offs and is powered by two 9 V batteries. A shielded cable and a phono jack connect it to the tank-controller interface, mounted inside the Big Trak.*



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KONAN™ in control

Listing 2: *An example of the user interaction produced by the program of listing 1. The coded command-specification characters transmitted to the tank show up in this printout on the next-to-last line, because the same I/O-port address was used for both the remote-control transmitter and the printer interface.*

```
run


COMPUTERIZED REMOTE CONTROL

Command list to be repeated each time (Y or N)? N
              COMMANDS :
      (M)ove                    (F)ire
      (C)lear                   (D)ump
      (H)old                    (G)o
      (R)epeat                  (D)ump
      (T)est

Command? M
(F)orward,(B)ackward,(L)eft,or (R)ight
? F
How many feet (1 to 99)? 2
                          Command Stored
Command? H
Hold how many seconds (total times .1sec)? 20
                          Command Stored
Command? F
How many shots (1 to 99)? 5
                          Command Stored
Command? M
(F)orward,(B)ackward,(L)eft,or (R)ight
? L
Turn how many degrees (0 to 360)? 90
                          Command Stored
Command? M
(F)orward,(B)ackward,(L)eft,or (R)ight
? F
How many feet (1 to 99)? 10
                          Command Stored
Command? F
How many shots (1 to 99)? 6
                          Command Stored
Command? R
Repeat how many steps? 2
                          Command Stored
Command? G
COMMAND CONTROL SEQUENCE IS BEING TRANSMITTED TO TANK


A!%1%&Q$25$!5&QTC%FTRANSMISSION COMPLETE

Retransmit Same Control Sequence (Y or N) ?
```

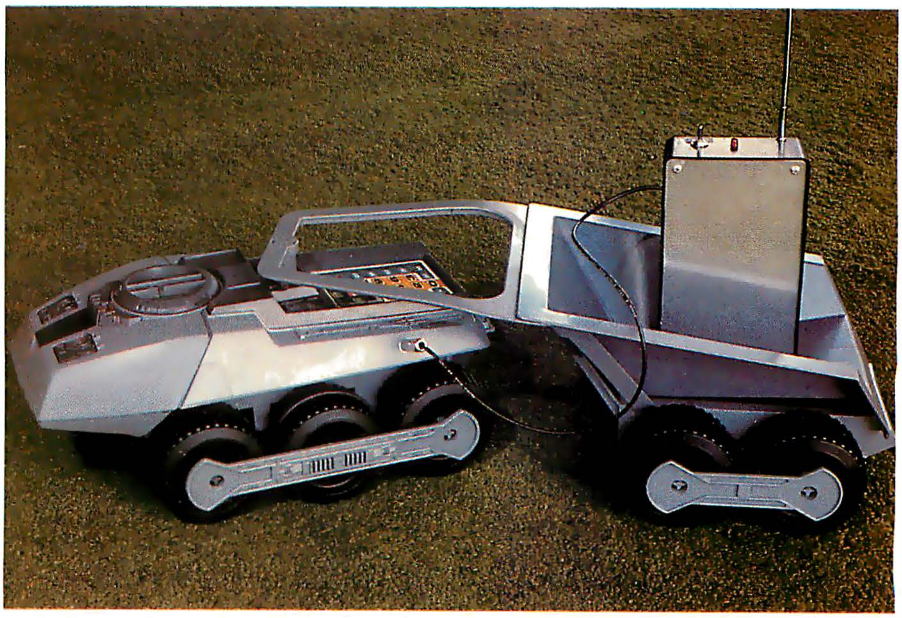
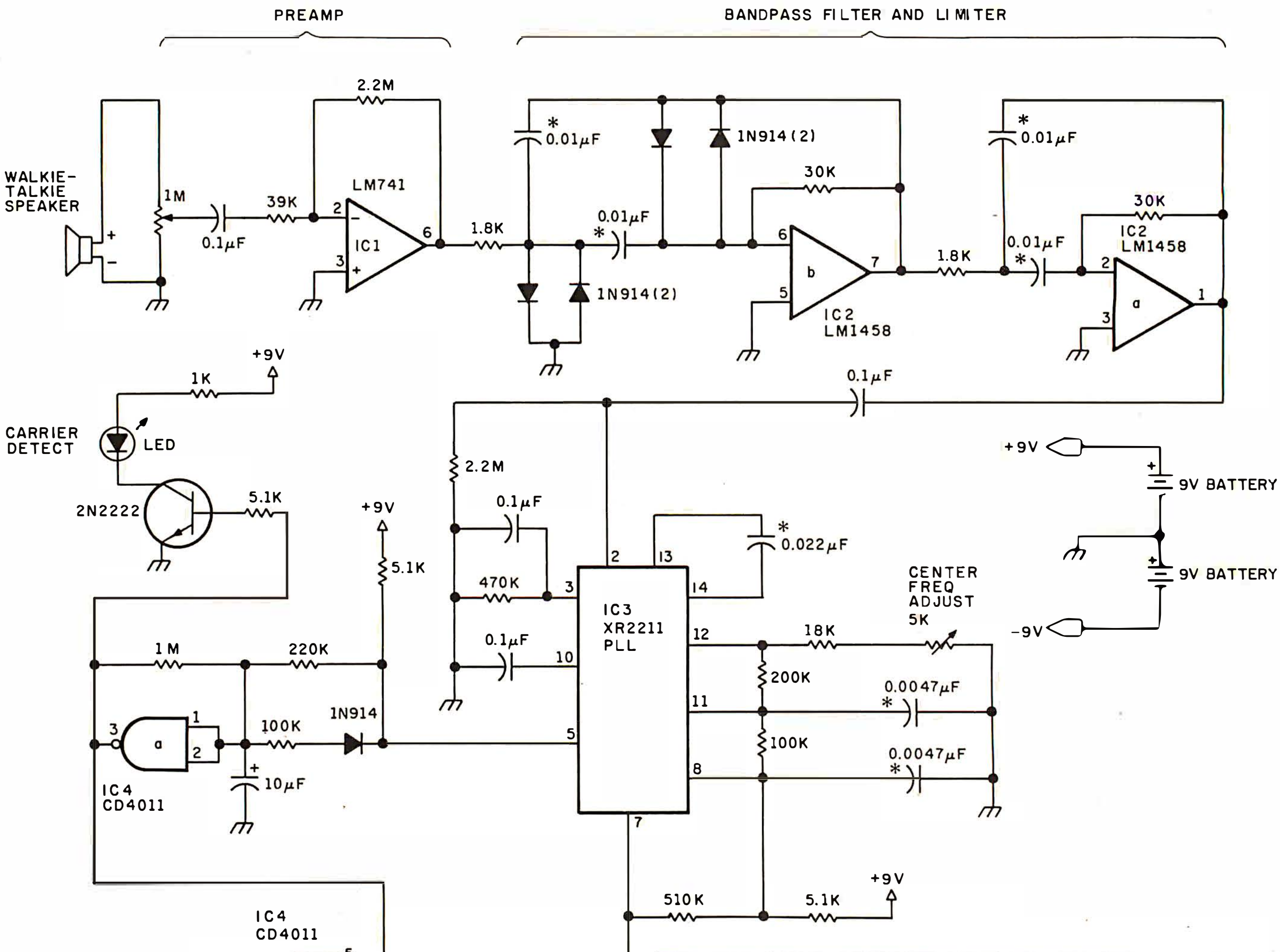


Photo 11: *When the electronic hardware has been built and is fully operational, the Big Trak Transport (a cargo trailer) provides a convenient method for dragging the wireless communication interface along.*



Number	Type	+9V	−9V	GND
IC1	LM741	7	4	
IC2	LM1458	8	4	
IC3	XR2211	1		4
IC4	CD4011	14		7

Figure 7: *The demodulator section of an originate-type modem. This is required at the receiving end of the computer/Big Trak link to decode the 2025 Hz and 2225 Hz tones received by the walkie-talkie. See photos 9 and 10 for views of the receiving system.*

The XR2211 phase-locked loop is produced by Exar Integrated Systems, POB 62229, Sunnyvale CA 94086. Capacitors marked with an asterisk (*) should be the type made from Mylar.

Text continued from page 60:
ics community, but neither will it go unnoticed by those of us who like to play with toys. I hope you will recognize the independent capability of the wireless serial-communication link and use it in another application.

As regards extensions of the control concept, a few more ideas came to mind while I was writing. The wireless communication method described in this interface is a one-way link, computer to remote peripheral device. However, the modem boards used in the prototype have full-duplex capability, even though only half of each unit is used. Furthermore, within the tank-controller interface, I did not use the transmit portion of the UART.

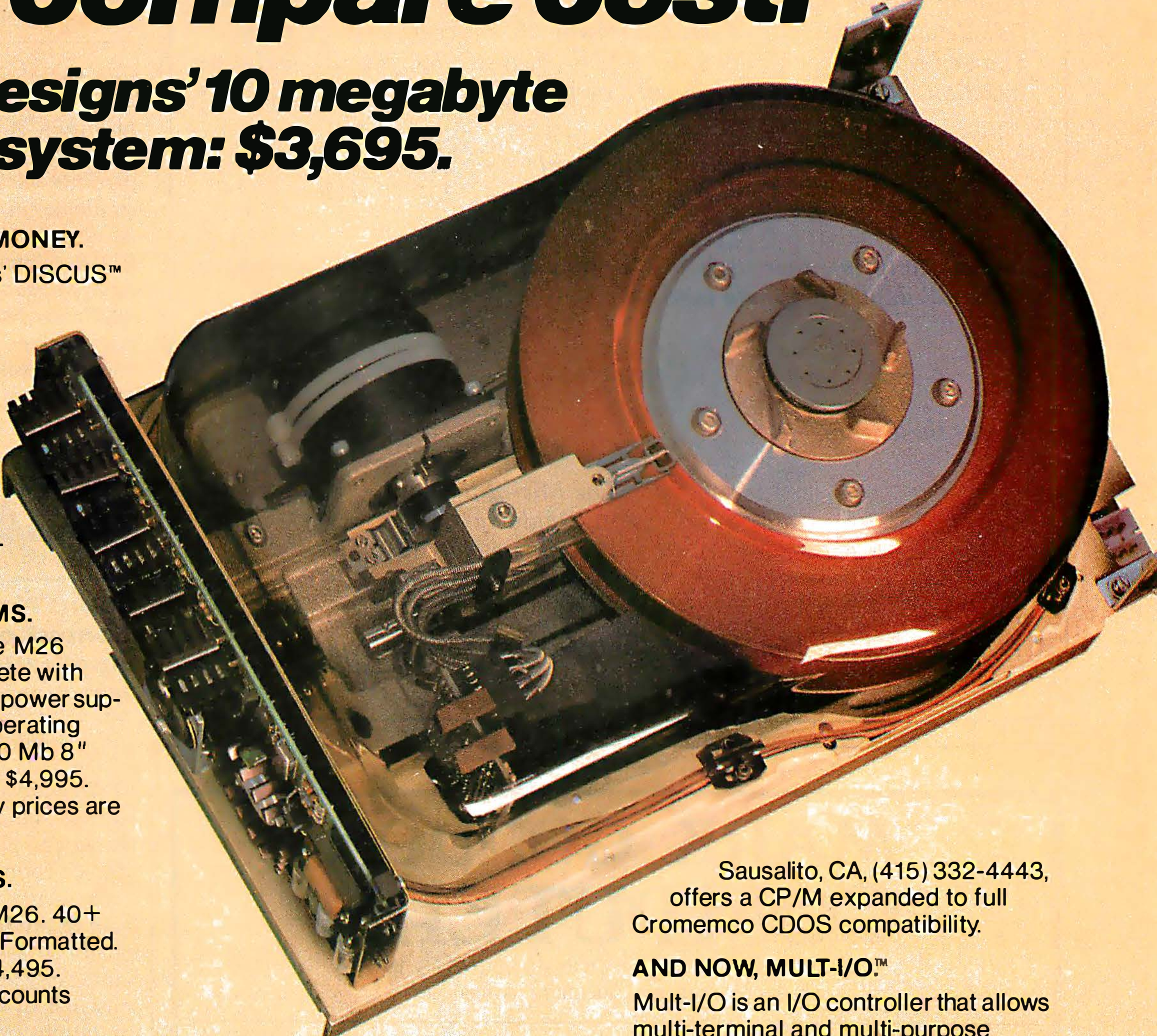
If two more walkie-talkies operating on a different frequency are added, or if the two existing units are switched back and forth between send and receive, we could conceivably receive data sent back from the tank. The required interface components are presently available in the hardware (the other halves of the two full-duplex modem boards) but are not utilized.

What data might the tank send back? Do you remember that article I did a while back on the Polaroid Ultrasonic Ranging System? [*In case you don't, see "Home In on the Range! An Ultrasonic Ranging System," BYTE, November 1980, page 32....***RSS**]

I'm sure you get the picture, but unfortunately I didn't have enough time to add that feature now. However, if you don't mind looking at Big Trak once more at a future time, I'd like to consider adding "eyes" and demonstrating control programs that exhibit more machine intelligence.

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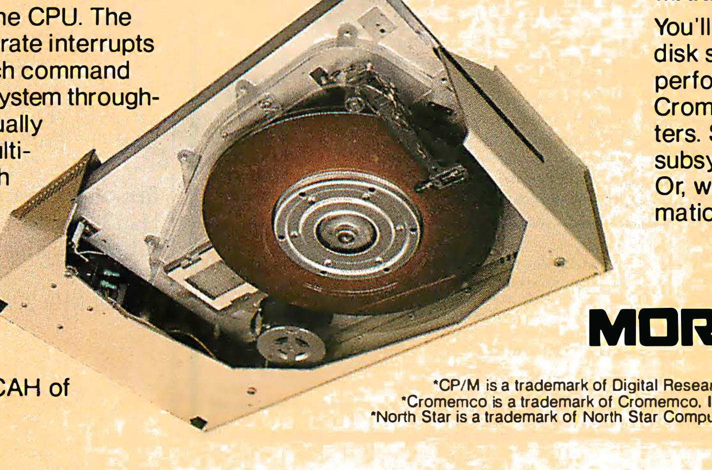
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Readers who wish to experiment with the wireless interface or want to build an inexpensive modem may order the following:

Blank printed-circuit board (shown in photos 7 and 10) and construction manual; can be built as either answer or originate full-duplex modem. Full details of the circuit on the board are described in "A Build-It-Yourself Modem for Under $50," BYTE, August 1980, page 22, and construction manuals included in each board.

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Editor's Note: *Steve often refers to previous Circuit Cellar articles as reference material for the articles he presents each month. These articles are available in reprint books from BYTE Books, 70 Main St, Peterborough NH 03458.* Ciarcia's Circuit Cellar *covers articles appeating in BYTE from September 1977 thru November 1978.* Ciarcia's Circuit Cellar, Volume II *presents articles from December 1978 thru June 1980.*

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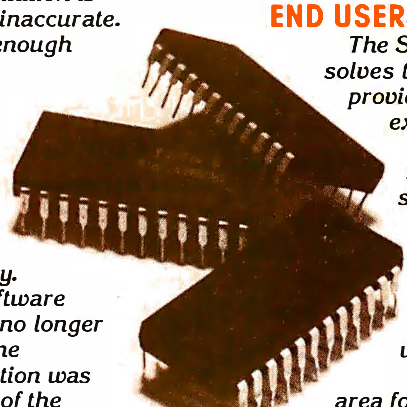


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A Beginner's Guide to Spectral Analysis
Part 1: Tiny Timesharing Music

Mark Zimmermann
9410 Woodland Dr
Silver Spring MD 20910

We live in two worlds that co-exist in space and time; they touch each other and interpenetrate at every point and at every moment. In fact, each world contains the other within it.

One is a world of forms, of colors, of sounds; the other is a world of complex numbers, of mathematical functions. Most people aren't aware of this second world, but that doesn't make it any less valid as an expression of reality. It's not hard to peek into this "alternate universe": this article and the accompanying programs will attempt to aid you in doing so. If a student devotes some time to the concepts suggested here, he'll find himself rewarded with a set of extraordinarily useful tools. Some facts which aren't obvious in one world are obvious in the other; some tasks which are slow, laborious, and expensive in the first world become quick and cheap in the second.

My description may sound a bit like Oriental mysticism, but it's not! This article will try to sketch an introduction to Fourier analysis, one of the most powerful developments in modern mathematics. It will emphasize the feel of the subject, not the complicated algebraic formalisms. No advanced mathematical training is required, but it may help to have access to a small computer for some parts of the discussion. The programs that I've written for illustrative purposes are in either BASIC or 6502 assembly language, and were specifically designed for the 8 K-byte Commodore PET. It should be a fairly straightforward process to adapt these programs to comparable machines.

The first part of this article will introduce the one-dimensional Fourier transform, and emphasize its importance to music and human perception of sound. Included is a "tiny timesharing" program that is both educational and enjoyable. It generates simple musical themes using the building blocks of intervals, and varies these themes via a series of inversions. New musical elements are introduced pseudo-randomly, so the patterns never repeat, and the tone quality is also constantly varied. All of this uses only about 0.1% (yes, one-tenth of one percent!) of the computer's time, which allows other programs to be run simultaneously with no noticeable loss of speed.

The "tiny timesharing" program generates simple musical themes using only 0.1% of the computer's time.

In the second part of this article, I will outline the simple extension of a one-dimensional problem into a two-dimensional plane. The program that illustrates this process uses pictures drawn on the PET's video-display screen and transforms them by a process similar to that of making a hologram with coherent light.

The references at the end of each part should be useful for anyone who wants more information on the topics encountered. You may also find it helpful to consult your neighborhood Fourier guru, who has probably chosen to be reincarnated as an electrical engineer or radio astronomer.

The Frequency Domain

The central idea of Fourier (or spectral) analysis is quite simple. One of the best ways to understand it is to think about a musical chord, produced by simultaneously hitting several keys on a piano. Suppose you play a chord and want to record it—how can you do that?

One way to preserve a chord for posterity would be to record it on a tape deck or (if you collect antiques) on a gramophone wax cylinder. In either case, the method of recording is essentially the same: the sound impulses are translated into magnetic field patterns, or into the wiggles of a groove, and stored just as your ear/microphone perceives them. If you had an oscilloscope, you could display the sound on a screen and photograph it.

But there's also a completely different way to save the chord. You can draw a musical scale and write down the notes that are hit. This scale doesn't show the moment-by-moment variations of air pressure against your eardrums; instead, it relates something about the *frequency* of these pressure waves, and the set of frequencies that is being created by the vibrating piano strings.

A recording method that stores a sound as a function of time is said to work in the *time domain.* A method that breaks a sound up into its constituent frequencies and records the amount of each frequency component that went into the original sound is said to work in the *frequency domain*.

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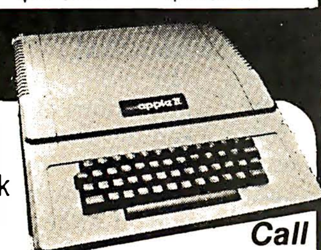
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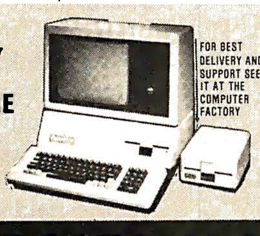
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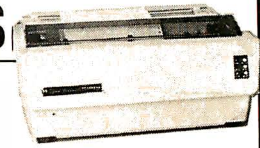
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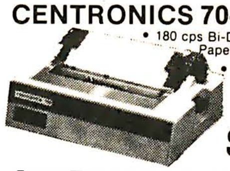
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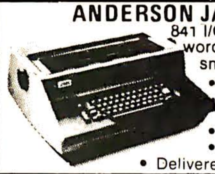
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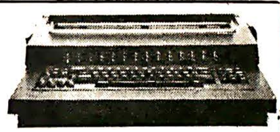
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notes on a scale doesn't give enough information to completely reconstruct the original chord. Even if each piano key produces a pure tone with no harmonics or distortions, you should still specify more than which keys were punched. You must say precisely how loud each note in the chord was played and the precise time that each note began (ie: the *amplitude* and the *phase* of each pure note in the chord). Given that amount of data, the original sound can be reproduced exactly. The frequency-domain method of recording then contains as much information as the conventional time-domain recording technique.

That's really all there is to Fourier analysis. There are, of course, precise mathematical formulas for translation from the time to the frequency domain, and back. There are also modern improvements on these formulas, such as the *fast Fourier transform*, which can do the same job in much less time than the old-fashioned method. But the basic ideas remain the same: the Fourier transform is a technique for changing notation from one way to another in order to record the same information.

There are many references (see references at the end of this article) that explain the mathematics of the Fourier transform. I'd like to avoid these, and try instead to explain the meaning of the transform, and the uses to which it can be put.

Why Transform?

I have already mentioned the application of Fourier analysis to music, and I'll return to this topic later. There are numerous other uses for the transform concept. Almost any wave-like phenomenon can show interesting behavior when looked at in the frequency domain. Light, when spread into a spectrum, reveals information about the source that produced it: that's how astronomers determine the composition of distant stars. (The word "spectrum" is the source of the term "spectral analysis.") Radio signals, grouped at different frequencies, carry hundreds or thousands of simultaneous telephone calls, TV broadcasts, etc. A receiver simply performs a partial Fourier analysis in order to separate one program from the crowd. Ocean waves can be resolved into frequency components, each traveling with its own speed. This approach helps, for example, in understanding how *tsunamis* (tidal waves) are created by undersea earthquakes and travel thousands of miles across the water before cresting on a shore.

Fourier analysis is also applicable to things that aren't functions of time. In calculating the heat distribution within a nuclear reactor core, one useful method involves breaking up the *spatial* dependence of the temperature into pieces that vary with different spatial frequencies. Similar techniques work to explain the shape of a soap film over a bent wire loop, the electrical field patterns inside a microwave cavity resonator, or the air density and pressure variations inside an organ pipe. (In the latter two cases, time dependences also exist as a part of the problem; the time dependences can be easily solved once the spatial Fourier analysis problem is understood.)

In recent years, myriad practical applications of spectral analysis have been developed, particularly in electrical engineering. If a signal is first transformed into the frequency domain, it often becomes easy to filter out noise and interference. On the other hand, by scrambling frequency components you can make a voice incomprehensible (unless the scrambling pattern is known) and allow relatively secure communications over a channel that is not secure. Quite often, it's most efficient to manipulate a signal by transforming it into the frequency domain, working it over, and then transforming back; the cost of transforming is more than repaid by the speed and convenience of many operations when applied to the frequency components of a function.

In the field of computing, Fourier analysis concepts have proved to be extremely helpful. The invention of faster algorithms as an aid in multiplying large numbers got its start from fast Fourier transform theorems. The spectral test for random number generators, one of the most powerful tests known for detecting non-random biases, is a Fourier technique. Even before electronic computers existed, mechanical "calculating engines" were built to do Fourier analysis because of the importance of the subject.

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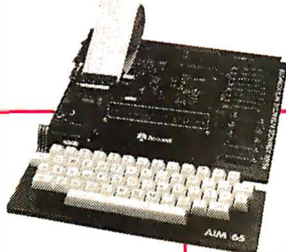
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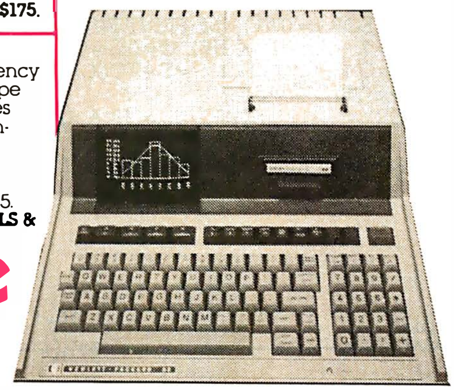


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Listing 1: *RMS Spectrum Plot for the Commodore PET. This program calculates and displays on the screen the Fourier components produced by a given bit pattern in the PET's shift register. The data is "played" with some extra hardware, as detailed in figure 1.*

```
1   REM N-BIT POWER SPECTRUM ANALYZER, COPYRIGHT 1979 MARK ZIMMERMANN
10  INPUT "NUMBER OF BITS"; NB: INPUT "HIGHEST HARMONIC"; HH
30  NM=NB-1: DIM S(NM), C(NM), F(NM), TS(NM,NM), TC(NM,NM)
40  FOR I=0 TO NM: X=2*π*I/NB: S(I)=SIN(X)/π: C(I)=COS(X)/π: NEXT I
50  INPUT "NOTE (1 TO 255)"; NT: POKE 59467,16: POKE 59464,NT
60  FOR I=0 TO NM: FOR J=0 TO NM: X=I*J: Y=X+I: X=X-NB*INT(X/NB):
    Y=Y-NB*INT(Y/NB)
70  TS(I,J)=S(Y)-S(X): TC(I,J)=C(X)-C(Y): NEXT J: NEXT I
80  REM SET UP MATRICES TO ALLOW SPEEDY INTEGRATIONS LATER
100 INPUT "TONE QUALITY"; D: IF D<256 THEN POKE 59466,D
110 DD=D: REM MAKE BINARY REPRESENTATION OF D IN LINE 120
120 FOR I=NM TO 0 STEP -1: F(I)=DD-2*INT(DD/2): DD=INT(DD/2): NEXT I
130 PRINT "[cls]";D;"=";: FOR I=0 TO NM: PRINT F(I);: NEXT I: PRINT
150 FOR K=1 TO HH: X=K-NB*INT(K/NB): C=0:S=0
160 FOR J=0 TO NM: C=C+TS(X,J)*F(J): S=S+TC(X,J)*F(J): NEXT J
170 C=C/K: S=S/K: A=SQR(C*C+S*S)
180 PRINT "[home]";: FOR I=1 TO 0 STEP -0.05: IF A>I THEN PRINT TAB(3*K); "♦";
190 PRINT: NEXT I
200 NEXT K: FOR I=1 TO HH: PRINT TAB(3*I-1);I;: IF I>8 THEN PRINT "[cl]";
210 NEXT I: PRINT
220 GOTO 100
```

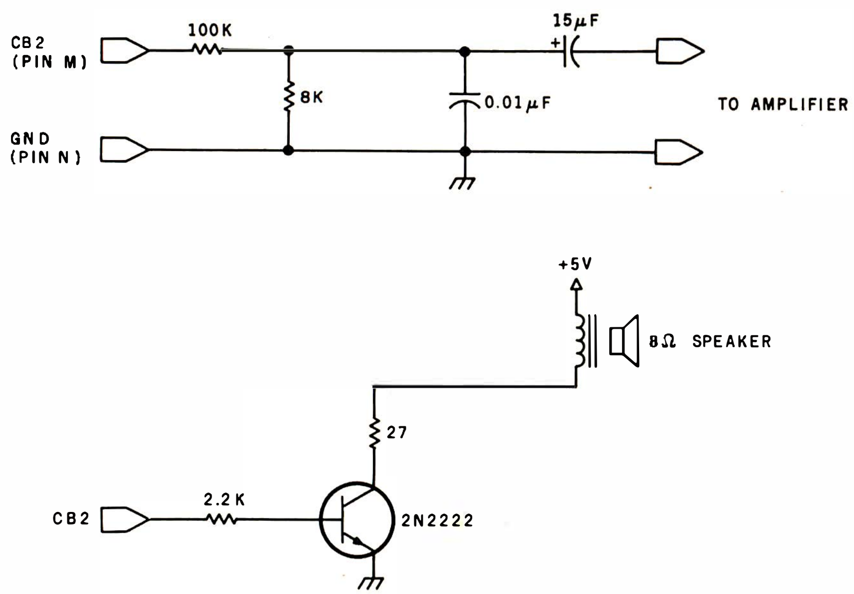


Figure 1: *Circuits to adapt the PET to a common audio amplifier (top), or to produce an audio output directly (bottom).*

Music and the Fourier Transform

Unlike the other senses, the ear seems to work naturally in the frequency domain. Physiologically this may result from the structure of the cochlea in the inner ear; sounds of different frequencies stimulate different spatially separated areas (so that the motion of the eardrum is Fourier transformed!). It is both interesting and educational to experiment with sounds of various frequency spectra. A microcomputer can be a great aid to this kind of experimentation, since it can reliably generate precise, easily modified waveforms, as well as perform the mathematical work required to calculate the spectrum of any particular wave. Both the pitch and the tone quality are variable.

The program RMS Spectrum Plot (see listing 1) was designed for just this kind of experiment. The mathematical parts can be run on any computer that understands BASIC; on the PET, the spectrum is graphically plotted on the video display, but a numerical output would be an acceptable alternative. This program also makes use of the recirculating shift-register in the MOS Technology 6522 VIA (Versatile Interface Adapter) integrated circuit in the PET. The VIA has an output to pin CB2 of the PET's port edge connector. Any trivial amplification circuit (see figure 1) can be used to amplify and isolate this output to give an audible tone. Many other microcomputers have similar tone-generation capabilities; otherwise, a separate waveform generator may be used to study the sounds that are being Fourier analyzed.

RMS Spectrum Plot performs a straightforward N-bit power-spectrum analysis. For use on the PET and most other microcomputers $N=8$ is the case of interest, but there is no harm in making a more general program and allowing for an arbitrary N. (Note that for N not equal to 8, the tones produced by the PET's shift register are not the same as the tones being analyzed by the program. Also note that for N greater than 16, PET BASIC will not correctly handle the array look-up operations for arrays TS and TC, which would need to have more than 256 elements.) I won't go into the mathematical operations that are being performed in the course of the spectral analysis: some of the references cited later do that in great detail. Instead, I'll try to explain the results, the physics and the physiology that the program helps explore.

Earlier I mentioned that in order to describe a sound completely in the frequency domain, you must provide more than just the list of frequencies that went into the original sound. A complete specification also requires the amplitude of each frequency component and its *phase*. By phase, I mean a measure of where a sinusoidal signal is in its cycle of 0° to 360° at some moment of time. (For example, the functions sin(t) and cos(t) look very similar, but one is 90° out-of-phase with the other.) Two sounds with the same set of component frequencies and the same amplitude can look completely different when displayed on an oscilloscope, and they make completely different wiggles in a phonograph groove (see figure 2).

So, phase information is crucial for the accurate reconstruction of the original sound. High-fidelity amplifier and speaker advertising emphasize this—you must spend lavishly in order to get really good, precise sound reproduction. Or must

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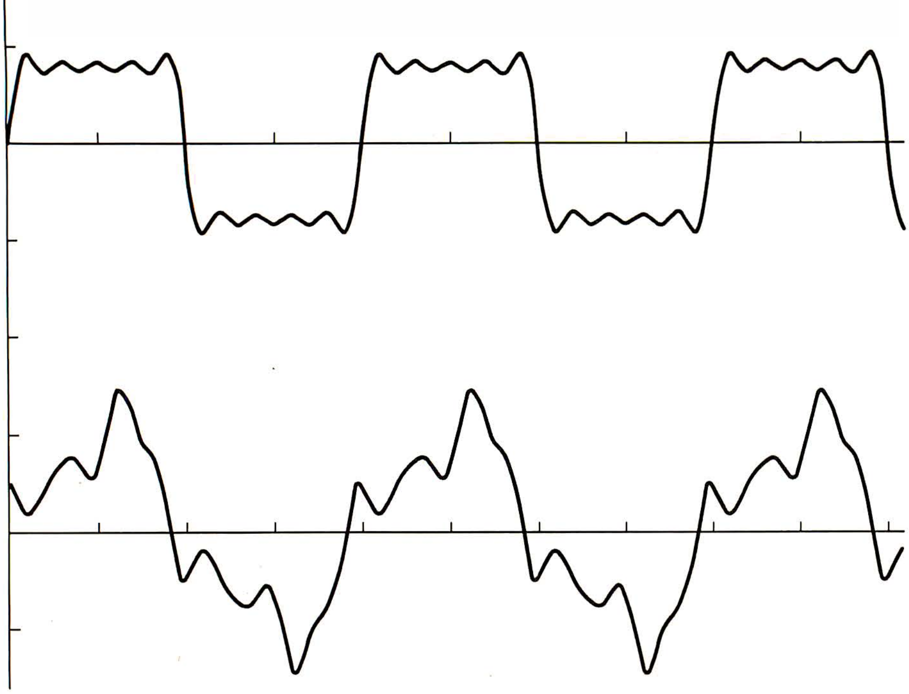
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$$f(t) = \sin(t) + \frac{1}{3}\sin(3t) + \frac{1}{5}\sin(5t) + \frac{1}{7}\sin(7t) + \frac{1}{9}\sin(9t)$$



$$f(t) = \sin(t) + \frac{1}{3}\sin(3t) - \frac{1}{5}\sin(5t) + \frac{1}{7}\cos(7t) - \frac{1}{9}\sin(9t)$$

Figure 2: *Different sounds that are composed of the same frequencies. These waveshapes are made up of the same component frequencies, but with a variation in phase between them.*

you? The program in listing 1 allows you to see the difference that phase information makes in perceived tone quality. In my experiments, I've found it to make *no* difference whatsoever. This agrees with most of the unbiased technical references I've read on the subject. The human ear is a marvelous Fourier analyzer as far as separating sounds into their component frequencies, but the ear seems to throw away almost all data about the phase of the sounds. (Perhaps some phase information helps to determine whether sounds are coming from the left, right, or in front of a listener, but that too is unclear.)

Even without phase information, sounds of the same fundamental frequency produced by RMS Spectrum Plot can reveal an interesting variety of textures as their bit patterns are changed. The program allows the user to set the shift register shift rate by choosing the value of the variable NT, between 1 and 255. The fundamental frequency of the output is then determined by the simple formula:

$$\text{frequency} = (62{,}500\ \text{Hz})/(\text{NT}+2)$$

For example, NT=140 closely approximates the standard frequency of 440 Hz, the note A above middle C.

Once the frequency of the note is chosen, RMS Spectrum Plot allows you to hear what an arbitrary bit pattern (waveform) sounds like, while the machine does a spectral analysis of the pattern and displays the results. These notes are composed of a fundamental frequency component, called f, plus varying amounts of sound energy at frequencies $2f$, $3f$, $4f$,...—the *harmonics* of the fundamental tone. After line 170 is executed, for each frequency $K \times f$, the variables C and S contain the amount of the Kth harmonic of the signal which looks like a cosine (in C) or like a sine (in S). A=SQR(C×C+S×S) is the amplitude of the Kth harmonic (the thing that the ear is sensitive to); it is this amplitude A which is plotted on the screen (see photos 1a, 1b and 1c for examples).

The best thing to do now is to stop reading and to experiment a bit with

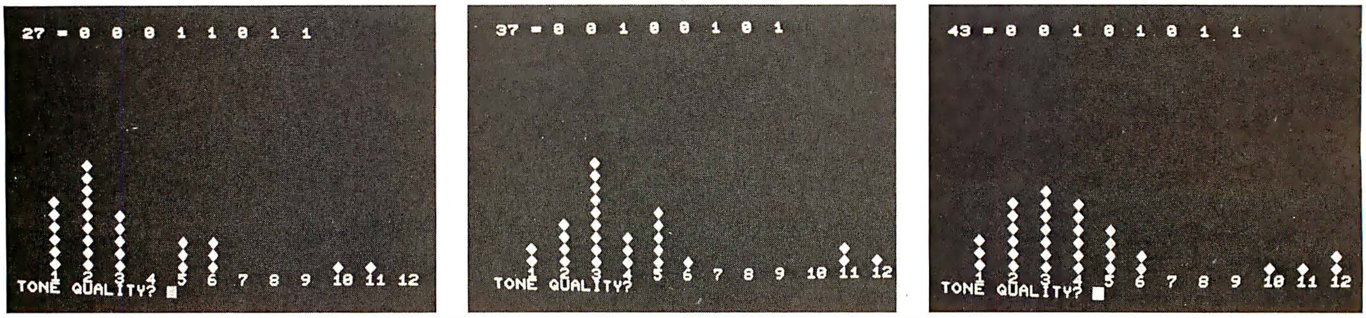


Photo 1: *Sample runs of RMS Spectrum Plot. The program "plays" an arbitrary bit pattern while displaying a power-spectral analysis of the sound.*

the program. Try to discover which bit patterns are indistinguishable to the ear; see which ones you like best. (My favorite is 00101101, which has no even harmonics and sounds rather like a clarinet.)

Distinctive Voices

The bit patterns that produce distinct frequency spectra are the basic building blocks for generating shift-register-type music. You can certainly find all seventeen different 8-bit voices by trial and error or long and tedious searching, but such an approach becomes much more difficult as the number of bits increases. In any case, there is a better way to find the set of interesting bit patterns: use a computer! The program Music Generator (listing 2) uses a technique that is simple, yet interesting, and applicable to many other problems.

In setting up the problem of finding all distinct voices, the first thing is to determine how two bit patterns can be "equivalent." (This is involved with the mathematical concept of a group, and is actually a good introduction to that subject.) First, it is obvious that patterns like 00000001 and 00001000 and 10000000 are all equivalent since they look the same (a single 1 and seven 0s) once they've started cycling around in the shift register. Similarly, 00101101 and 10100101 are equivalent: the second pattern results from applying five rotate-left operations to the first. We can call the operation which takes the leftmost bit of a bit pattern and moves it to the right end ROL for rotate-left. Any patterns which can be converted into each other by a series of ROL operations are equivalent.

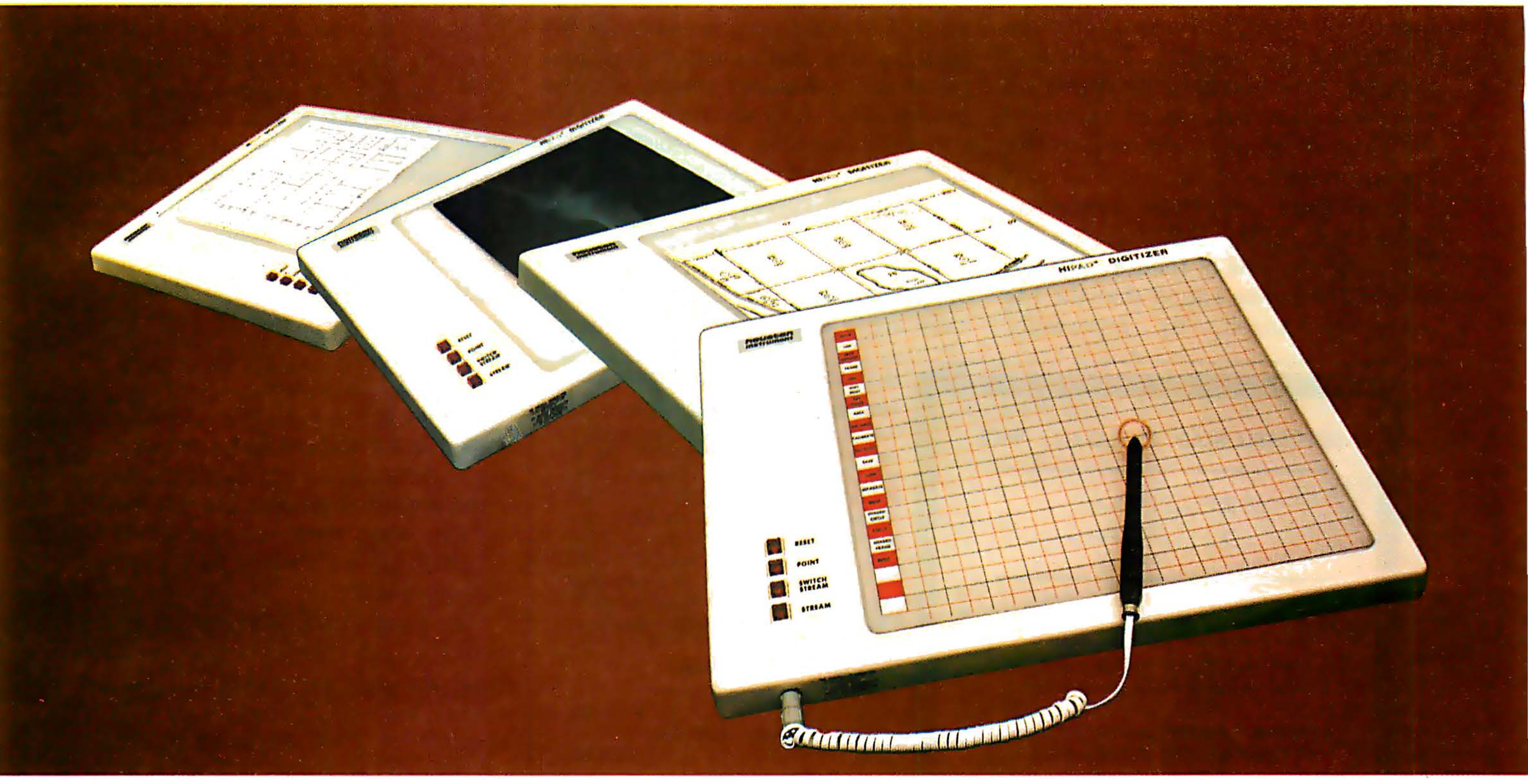
But there are other ways in which two bit patterns can be equivalent. Consider the patterns 11111101 and 00000010. If you graph these patterns, you can see that the waveforms to which they correspond are exactly the same, except for a shift of the zero-voltage level and a change of polarity. The power spectra of these patterns are also the same, except for the zero-frequency component which the ear can't hear and which isn't plotted by RMS Spectrum Plot. (The zero-frequency component is just the average of the bits, eg: $^7/_8$ for the pattern 11111101.) Since these patterns are the same as far as the ear is concerned, they should also be called equivalent. In binary arithmetic, the relation between these patterns is that each is the 1's complement of the other: all 1s are changed to 0s, and vice versa. Since the 1's complement of a binary number *I* is just 11111111-*I* (if *I* has 8 bits), it's easy to program in BASIC. We can call this operation INV for inverse, and add it to the list of operations that transform bit patterns into other, equivalent patterns.

Listing 2: *Music Generator for the PET. When used to generate music waveforms, this program will produce audibly distinct tones based on 8-bit patterns in the PET's shift register. Qualities are constantly modified through the application of symmetry operations (inversion, rotation, etc) to produce interesting variations.*

```
  10 REM BIT PATTERN GENERATOR (C) 1979 MARK ZIMMERMANN
  20 DIM V%(7): REM ARRAY FOR BIT PATTERN DISPLAY
 100 FOR I=1 TO 127 STEP 2: REM TRY ALL POSSIBILITIES THAT DO NOT OBVIOUSLY
     FAIL
 200 Z=I: FOR K=1 TO 7: GOSUB 5000: REM ROTATE BITS OF Z LEFT
 220 IF Z<I GOTO 1000: REM REDUCED TO A PREVIOUS CASE IF Z<I
 240 NEXT K: REM PASSED FIRST TEST IF REACH HERE
 300 X=255-I: REM INVERT BIT PATTERN (1's COMPLEMENT)—X>I SINCE LOOP WAS
     1 TO 127
 320 Z=X: FOR K=1 TO 7: GOSUB 5000: REM ROTATE BITS
 340 IF Z<I GOTO 1000: REM REDUCED TO PREVIOUS CASE...
 360 NEXT K: REM IF HERE, PASSED SECOND TEST
 400 GOSUB 6000: REM REVERSE BIT ORDER OF I, RESULT RETURNED IN X
 500 IF X<I GOTO 1000: REM FAILED AGAIN
 600 Z=X: FOR K=1 TO 7: GOSUB 5000: IF Z<I GOTO 1000
 620 NEXT K
 660 Z=255-X: FOR K=1 TO 7: GOSUB 5000: IF Z<I GOTO 1000
 680 NEXT K: REM IF HERE, A SUCCESS!!!!!
 800 X=I: FOR K=0 TO 7: V%(K)=X-2*INT(X/2): X=INT(X/2): NEXT K: REM
     GENERATE BITS
 900 PRINT I;TAB(10);: FOR K=7 TO 0 STEP -1: PRINT V%(K);: NEXT K: PRINT
1000 NEXT I
2000 GOTO 9999
5000 REM ROTATE BITS OF Z LEFT
5020 Z=2*Z: IF Z>255 THEN Z=Z-255
5040 RETURN
6000 Y=I: X=0: FOR K=0 TO 7: X=2*X: IF Y<>2*INT(Y/2) THEN X=X+1
6020 Y=INT(Y/2): NEXT K: RETURN: REM RETURN WITH X THE REVERSED VERSION OF
     I
9999 END
```

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I've only been able to think of one more symmetry operation to apply to bit patterns. (If you find others that leave the voice that the ear hears unchanged, please let me know.) This final operation is to reverse the bit order. For example, reversal changes 11010000 into 00001011. Physically, reversal corresponds to playing a bit pattern backwards, or to reversing the flow of time. I abbreviate this operation REV.

Now there are three symmetry operations: ROL, INV, and REV. Applying any one of them to any bit pattern leaves the sound that the ear hears unchanged. By repeatedly applying these operations, it's easy to discover sets of bit patterns that change into each other (the patterns 00110011, 01100110, 10011001, and 11001100 make up one such set).

How does this theoretical knowledge help you to determine which bit patterns are distinctive voices and which are redundant among the 256 possibilities? A crude way would be to apply various combinations of ROL, INV, and REV to a candidate pattern, and consider it new if it is never transformed into an already-known or old pattern. A slightly better method would be to systematically apply a series of the symmetry operations that would guarantee that no possible transformations were missed. For example, it's clear that you need never apply more than seven consecutive ROL operations to a pattern, since the eighth application brings you back to the original pattern. It's also clear that applying INV (or REV) twice in a row makes no sense, since it just flips the bits back again. There are many possible sequences of operations that will find all possible transformations of a pattern. One simple sequence is: ROL seven times, INV, ROL seven times, REV, ROL seven times, INV, and ROL seven times. After each operation, a potentially new equivalent bit pattern is produced. Applying the sequence to the pattern 00001011 will generate all thirty-one other equivalent patterns, with no repetition; applying it to a pattern like 01010101, which has only one equivalent (10101010), will, of course, produce many repetitions.

The program of listing 2 essentially goes through this process in order to find the set of seventeen distinct voices, but with a few refinements to speed it up. First, the program works exclusively with the decimal number corresponding to each bit pattern, not with the pattern itself. This allows the program to use simple BASIC arithmetic operations to perform ROL, INV, and REV. Only when a number is discovered to be a new voice is it converted into a bit pattern for display. Second, no time is wasted in checking even numbers, or numbers greater than 127. Every even number corresponds to a bit pattern ending in a 0, and a single rotation right (or seven rotations left) will always produce a pattern corresponding to a smaller binary number. Any number greater than 127 can always be reduced to a number less than 127 by an INV operation. Third, Music Generator doesn't bother storing a list of already-discovered old patterns with which to compare the result of each transformation. Instead, it uses a neat yet trivial mathematical trick, one that should be part of every alert programmer's repertoire. Let me introduce it to you with a short story:

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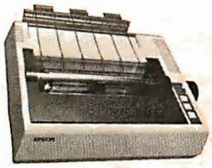


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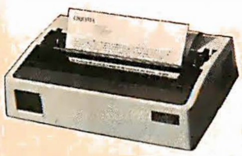
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```
                    P=0
                    Q=1                          ;P,Q,R occupy "USR(X)" storage area!
                    R=2
               RNDPTR=DD (hexadecimal)
               RNDNUM=DE (hexadecimal)           ;random numbers in PET's RND(X) location
                    D=EC (hexadecimal)           ;in PET's "EOT character" area
                    V=F3 (hexadecimal)
                    N=F4 (hexadecimal            ;V,N in tape buffer pointer area
```

M1=033A (hexadecimal)=826 (decimal)
M2=036C (hexadecimal)=876 (decimal)
I =03D8 (hexadecimal)=984 (decimal)
Music table occupies 03D9 thru 03E0 (hexadecimal)=985 thru 992 (decimal).
INTRVLTAB=03E1=993
Interval table occupies 03E1 thru 03E8 (hexadecimal)=993 thru 1000 (decimal).
NOTETAB=03E8=1000
Note table occupies 03E8 thru 03FF (hexadecimal)=1000 thru 1023 (decimal). Note overlap with interval table.

Contents of tables:

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
03E0:	—	00	00	04	F9	07	F5	0C	FB	ED	E0	D3	C7	BC	B1	A7
03F0:	9D	94	8C	84	7C	75	6E	68	62	5C	57	52	4D	49	45	41

Algorithm Description

M1. (Initialize) Point PET hardware interrupt vector to M2. SET Q, R, and N to 8; zero music table I(1), I(2), ... , I(8). Set P, V, and D to 1.

M2. (Interrupt enters here) Decrement note duration counter D; if result is nonzero, go to PROCEED below.

M3. (Next note) Reset D to 4 (or other chosen length of note to be played, in units of 1/60 second). Look up interval I(P) and add that to note N, staying in allowed range (0 to 23). Decrement pointer P; if result is nonzero, go to step M6.

M4. (A measure of eight notes has been completed) Reset P to 8. Decrement voice V (bit pattern making sound) by 4 (or other choice), and if result is negative, reset V to maximum (=85). Change voice of note (POKE 59466, V). If counter Q is nonzero, invert interval I(Q) by negating value of I(Q), decrement Q and go to step M6.

M5. (All eight inversions have been completed) Reset Q to 8. Replace interval I(R) by another "randomly" chosen interval from the allowed table of intervals (in musical notation, table contains thirds, fifths, octaves, etc). Decrement R, and if R becomes 0, reset R to 8.

M6. (Play next note) Play new note NOTETAB(N), looked up in notetable. (POKE 59464, NOTETAB(N).)

PROCEED. Jump to PET's normal interrupt-handling routine (E685).

To use Tiny Timesharing Music give command SYS(826) to turn music on and off. (You *must* turn it off before tape operations, since the PET uses the same interface chip when reading/writing tapes....)

distinct-tone-quality bit patterns. (Patterns 00000000 and 11111111 are not included, since they're inaudible.)

When written as binary numbers, the legal (irreducible) bit patterns have some interesting resemblances to the set of prime numbers (numbers that have no positive factors except themselves and 1). They are quite dense at the lower end of the range of available numbers, but become fewer and farther between as the candidate numbers get larger. There's a simple reason for that: if a large number is chosen at random, it's likely that some combination of the operations ROL, INV, and REV will be able to transform it into a smaller number, a previous case. (Similarly, there is a good chance that a large integer chosen at random has a factor among the many smaller integers between itself and 1, so the density of prime numbers decreases.) However, even as you go to higher numbers, an occasional pair of distinctive bit patterns appears, separated by a single even number. Among the 8-bit musical patterns, the pair 43=00101011 and 45=00101101 is a good example of such a "musical-pair"; if you look at 16-bit patterns, which potentially range from 1 thru 65535, pairs such as 11059, 11061 can be found. Prime numbers can also come in such pairs; as far as I know, however, there is no proof that an infinite number of prime pairs exist. There may be other analogies between the theory of primes and the distinct-voice musical bit patterns—I'd be interested in hearing about your discoveries.

From Tones to Music

I began this discussion with a look

```
M1:       SEI                 ;disable interrupts during changeover
          LDA $0219           ;PET hardware interrupt vectors thru $0219,021A
          EOR #$E9            ;changes normal contents, $85, to $6C, and vice versa
          STA $0219
          LDA $021A
          EOR #$E5            ;changes $E6 to $03, and vice versa
          STA $021A
          LDA $E84B           ; = 59467, auxiliary control register
          EOR #$10            ;change $00 to and from $10 (free-running shift out)
          STA $E84B
          LDY #8              ;now initialize page zero music counters
          STY Q
          STY R
          STY N
          LDA #0
LOOP1:    STA I,Y             ;clear out music table in I+1 thru I+8
          DEY
          BNE LOOP1
          INY
          STY P               ;initialize more page zero counters
          STY V
          STY D
          CLI                 ;re-enable interrupts
          RTS
M2:       DEC D               ;this is where interrupt vector was changed to point to
          BNE PROCEED         ;keep playing same note for duration D
M3:       LDA #8              ;value may be changed to vary tempo...4 thru 16 is nice...
          STA D
          LDX P
          LDA I,X             ;fetch next interval from music table to be added to note N
          CLC
          ADC N
          BPL OVER1
          ADC #$0C            ;if displacement made N negative, add 12 to move up an
                              octave
          BPL OVER2           ;always take the branch (this could be omitted to save 2
                              bytes)
OVER1:    CMP #$18            ;make N less than 24
          BCC OVER2
          SBC #$0C            ;subtract an octave to get in range
OVER2:    STA N
          DEC P               ;move note pointer back one
          BNE M6              ;go to play note if nonzero
M4:       LDY #$8
          STY P               ;reset pointer P
          LDA V
          SEC                 ;change voice (tone quality, bit pattern shifted out) used
          SBC #4              ;change this number 4 if other patterns are desired
          BPL OVER3
          LDA #$55            ;reset to maximum interesting pattern (=85 decimal)
OVER3:    STA V
          STA $E84A           ; = 59466, shift register
          LDX Q
          BEQ M5              ;branch if it's time to change an interval randomly
          SEC
          LDA #0
          SBC I,X             ;invert an interval (negate it) in music table
          STA I,X
          DEC Q
          BPL M6              ;always take branch
M5:       STY Q               ;reset Q to 8
          INC RNDPTR          ;move pointer forward
          LDX RNDPTR
          LDA 0,X             ;get a "random" number from page zero
          EOR RNDNUM          ;mix its bits with previous "random" ones
          STA RNDNUM          ;save them for future mixing
          AND #$7             ;mask out bits to get a "random" # in range 0 thru 7
          TAX                 ;prepare to take an interval from INTRVLTAB table
          LDA INTRVLTAB,X
          LDX R               ;find out which music table entry to alter
          STA I,X             ;insert new "random" interval
          DEC R
          BNE M6
          STY R               ;reset R to 8 if necessary
M6:       LDX N               ;find what note to play
          LDA NOTETAB,X
          STA $E848           ; = 59464, controls shift rate
PROCEED:  JMP $E685           ;return to normal interrupt-handling chores
```

Listing 3: *Tiny Timesharing Music. This interrupt-driven program runs concurrently with other PET programs, and uses their changing data to update its tone-parameters (see the text box "Algorithm Description"). The interrupt occurs every* $\frac{1}{60}$ *of a second to cause the PET to check the keyboard for closed keys.*

at Fourier analysis, and have wandered through a bit of group theory in looking at shift-register-generated tones and what they sound like. I'd like to close with a practical application of this material.

I often run fairly long programs, and it can be boring to stare at a static video screen, waiting for the results to appear. Then, too, I sometimes become paranoid and suspect that the machine has crashed, leaving me to wait forever. Well, I thought, why not put a little musical theory to work? Why not have music while I'm waiting for the programs to finish?

The more I thought about it, the better the proposal sounded. The PET is always interrupted sixty times per second, to scan the keyboard and update the internal clock. (This happens as long as the interrupt-disable flag hasn't been set in the 6502 microprocessor; the flag is rarely set during normal operation.) At each interrupt, the microprocessor branches to the address stored in memory locations 0219,021A. Normally, these addresses point to hexadecimal location E685, but by changing the address pointed to, I could take control once every $1/60$ second—and play music!

The requirements that a good interrupt-driven music-generation program must meet are rather severe:

1. It must produce interesting musical patterns, neither too repetitious nor too chaotic.
2. It must be fast so that the main program does not slow down appreciably while music is playing.
3. It must be small; the main programs must not be squeezed out of memory or restricted by the music generator.

The program shown in listing 3 resulted. Tiny Timesharing Music meets the third requirement by occupying only the memory at locations 826 thru 1023 (second cassette buffer), plus five locations on page zero. It satisfies the second requirement by being fast; running at normal

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speed it uses about 18 μs every 1/60 second—only 0.1% of the machine's time. (Changing notes at top speed uses less than 0.4% of the time.) As for whether or not it meets the first criterion, you'll have to judge for yourself: "interesting" is in the ear of the beholder. I enjoy it, although it's certainly nowhere near Bach's *Art of Fugue*...then again, nothing is.

The algorithm description which accompanies this listing (see the text box "Algorithm Description") should make its method of operation clear. The theory of music is beyond the scope of this article (and me!), but in brief, the program works as follows: first it generates eight intervals, chosen from a musically "nice" set of possibilities (see Arthur Benade's book, and other references, for more details). Beginning with a base note, eight notes are played, each related to the previous note by one of the chosen intervals. After a measure of eight notes is completed, the bit pattern (voice) being used by the shift register is changed, one of the eight intervals is inverted, and another measure is played. (Inversion simply amounts to a sign change: an interval of +7 (a fifth) is inverted to −7.) After all eight intervals have been inverted, one is replaced by a new, randomly-chosen interval, and the whole process is repeated. The "random" numbers are influenced by the contents of page zero, so if the user is doing something, or running any program, the musical patterns produced will never repeat for long.

As always, I will be delighted to learn of any improvements that readers make in this musical program. The best way to test ideas for musical pattern generation is to run them as non-timeshared BASIC programs. Then they're easily modified and debugged, and if they sound good, they can be coded in assembly language. In Tiny Timesharing Music as presently written, it's easy to change the tempo of the notes: just POKE 881,X where X is the length of the notes in units of 1/60 second (values of X between 4 and 16 seem to work best). The contents of memory location 918 govern the changes between one voice and the next: the number there (and in location 922) may be changed to vary the sequence of bit patterns used. The table of musical intervals in locations 993-1000 can be varied according to taste, as can the table of notes (1000-1023; note that one table entry is in common, to save space). I use a digital approximation to a well-tempered scale, but you may prefer another choice. ■

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Programming Quickies

Converting Pitch to Frequency

Robert Katz, 248 E 90th St, #3B, New York NY 10028

This program converts pitch to frequency and can use either the piano tuner's scale (based on a perfect fifth interval), or the scientific, or "just," scale (based on a perfect octave interval). The scales are equally tempered in either case.

The program is written in RPN (reverse Polish notation) for a Hewlett-Packard calculator. Step 8 includes a *GTO* instruction. If your calculator has labels instead of step numbers, use a label at steps 8, 10, 32, and 35.

To use the program, place a number from 1 to 7 in the *x* register. This represents one of the notes from C to B in the 12-note scale. To indicate the standard "whole" tones, use a whole number (such as 1 for C, 6 for A, etc). To indicate an accidental, use an integer plus 0.5 (6.5 for A#, 2.5 for D#). If the tones are to be in the octave of middle C, make sure a 0 is contained in the *y* register. Otherwise, the number in the *y* register should be an integer representing the number of octaves above or below middle C. For example, 5.5, −2 represents G#, two octaves below the octave of middle C. Once the pitch has been entered, all you have to do is press R/S. For example, enter (6, 0) and press R/S. This will display 440, which is the pitch of A in the octave of middle C.

The formula is:

$$261.25 \times \left(\sqrt[7]{3/2}\right)^{P_1+P_2}$$

Listing 1: *A program to convert pitch to frequency. This listing is in the RPN (reverse Polish notation) for a Hewlett-Packard calculator. If your calculator uses labels instead of step numbers, a label must be used at steps 8, 10, 32, and 35. In a calculator with continuous memory, steps 15 thru 21 and steps 24 thru 29 can be replaced with a constant recalled from memory.*

```
 1.  f fix 0
 2.  1
 3.  −
 4.  2
 5.  ×
 6.  5
 7.  f x≤y
 8.  GTO 32
 9.  ↓
10.  x↔y
11.  1
12.  2
13.  ×
14.  +
15.  1
16.  .
17.  5
18.  ENTER
19.  7
20.  g 1/x
21.  f y^x
22.  x↔y
23.  f y^x
24.  2
25.  6
26.  1
27.  .
28.  2
29.  5
30.  ×
31.  GTO 00 (or g RTN)
32.  ↓
33.  1
34.  −
35.  GTO 10
```


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Intel has adopted CIS COBOL and offers it (as iCIS-COBOL) for their Intellec and Intellec II systems. Ideal for OEM's or private label, CIS COBOL was developed entirely by Micro Focus. Send inquiries for CIS COBOL object packs and application vendor terms to MICRO FOCUS or its licensed distributors. Distributor terms also available from MICRO FOCUS.

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where P_1 is a power within the octave of middle C. P_2 is a power that will reach any octave above or below middle C. Steps 15 thru 21 compute the seventh root of $^3/_2$, which is the relationship of a semitone within the piano-tuner's scale, based on perfect fifths and stretched octaves. Replace steps 15 thru 21 with the twelfth root of 2 and you will have the standard, perfect octave scale. When using the perfect octave scale, you may have to change steps 24 thru 29 to 261.63 to obtain an A 440. Steps 24 thru 29 are the frequency of middle C, on which the program is based. Note also that steps 32 thru 35 are a correction factor based on the half step between E and F in the scale.■

BYTE's Bits

NSF Awards Education Grant

The NSF (National Science Foundation) has awarded Educational Solutions Inc a grant for the development of courseware that will demonstrate new ways to teach numeration, addition, and subtraction. The New York City-based research and development organization's approach stresses learning through insight and practice rather than rote memorization. Feedback from the instructor helps guide and refine the student's growing insight. According to Educational Solutions's hypothesis, perceptual activities, feedback, and practice eventually teach the student practical skills.

Under the provisions of the grant, Educational Solutions must first produce a prototype of the courseware, then test it on public school students. After analysis, the courseware will be revised and prepared for distribution.

OSU's TABS Project

The College of Education at OSU (Ohio State University) is busily at work on project TABS. The purpose of this project is to develop and disseminate curricular materials in which high technologies are used to teach basic mathematical skills such as problem solving, estimation, and computer literacy. Funded by the US Department of Education, project TABS's goal is to collect and evaluate existing educational software for microcomputers and select the highest quality programs for distribution. The programs are to be field tested and distributed nationally.

Individuals or groups who have developed mathematics software for the upper elementary-school level are invited to submit their work for possible inclusion in the project. To have materials considered, send a cassette tape or floppy disk with a printout, machine documentation, and any related information to Dr Suzanne K Damarin, TABS Project, Arps Hall 202-A, 1945 N High St, Columbus OH 43210, (614) 422-1257.■

Software Review

Infinite BASIC and Infinite Business

Scott Mitchell, 346 S Taylor St, Manchester NH 03103

Infinite BASIC is a software-utility package for the Radio Shack TRS-80 sold by Racet Computes. The package has a suggested retail price of $49.95, with an optional Infinite Business package available for $29.95.

The purpose of these packages is to add extra commands to either your disk BASIC or Level II cassette system. Infinite BASIC adds eighty commands to your BASIC vocabulary, so if you thought the Level III add-on for your cassette system was a good deal, you'll consider this a steal for the same price. Level III BASIC (from Microsoft Consumer Products, Bellevue, Washington) always consumes 4 K bytes of memory, even if you use only one or two of its features in your program. Infinite BASIC lets you take only the features you want and put them on a system tape or disk file, thereby saving memory space. Also, you can place the resulting object code in memory anywhere you wish. These two features make Infinite BASIC a versatile package for both disk and tape users.

Infinite BASIC—Matrix and Strings

Infinite BASIC is the foundation of the program set.

Text continued on page 100

At a Glance

Name
Infinite BASIC and Infinite Business

Type
BASIC extension software system with independent application modules

Manufacturer
Racet Computes
702 Palmdale
Orange CA 92665
(714) 637-5016

Price
Infinite BASIC: $49.95; Infinite Business: $29.95

Format
5-inch floppy disk or tape cassette

Language
Z80 machine language

Computer
Radio Shack TRS-80 with either disk BASIC or Level II cassette system

Documentation
Printed booklets 14 by 22 cm (5½ by 8½ inches); for Infinite BASIC, two booklets totaling 84 pages; for Infinite Business, one booklet with 21 pages

Audience
Business, game, and general programmers

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Listing 1: *Sample string-manipulation program and run. Note that the commands are small and compact. The program initializes string A$, performs a function on it, and prints it out. After each printout of the modified string, A$ is reset to its original contents and the next operation is performed. With each command that modifies A$, the modified string is stored in J$. However, it could simply be put back into A$. The program runs quite fast.*

```
1 CLS
10 GOSUB1000
11 PRINT:PRINT"A$ = (";:PRINTA$;:PRINT")"
20 J$ = &SLR$(A$,6):' LEFT ROTATION COMMAND
21 PRINT"LEFT ROTATE BY 6 = (";:PRINTJ$;:PRINT")"
30 GOSUB1000
40 J$ = &SRR$(A$,6):' RIGHT ROTATION COMMAND
50 PRINT"RIGHT ROTATE BY 6 = (";:PRINTJ$;:PRINT")"
60 GOSUB 1000
70 J$ = &SLJ$(A$):'LEFT JUSTIFICATION COMMAND
80 PRINT"LEFT JUSTIFIED = (";:PRINTJ$;:PRINT")"
90 GOSUB1000
100 J$ = &SRJ$(A$):'RIGHT JUSTIFICATION COMMAND
110 PRINT"RIGHT JUSTIFIED = (";:PRINTJ$;:PRINT")"
120 GOSUB1000
130 J$ = &SLT$(A$):'LEFT TRUNCATION COMMAND
140 PRINT"LEFT TRUNCATED = (";:PRINTJ$;:PRINT")"
150 GOSUB1000
160 J$ = &SRT$(A$);'RIGHT TRUNCATION COMMAND
170 PRINT"RIGHT TRUNCATED = (";:PRINTJ$;:PRINT")"
180 GOSUB 1000
190 J$ = &SLS$(A$,4):' LEFT SHIFTING COMMAND
200 PRINT"LEFT SHIFTED BY 4 = (";:PRINTJ$;:PRINT")"
210 GOSUB1000
220 J$ = &SRS$(A$,6):' RIGHT SHIFTING COMMAND
230 PRINT"RIGHT SHIFTED BY 6 = (";:PRINTJ$;:PRINT")"
240 GOTO240
1000 A$ = " ABCD  EF "
1010 RETURN
9999 END

RUN
 A$ = ( ABCD  EF )
 LEFT ROTATE BY 6 = (D  EF   ABC)
 RIGHT ROTATE BY 6 = ( EF   ABCD )
LEFT JUSTIFIED = (ABCD  EF   )
RIGHT JUSTIFIED = (   ABCD  EF)
LEFT TRUNCATED = (ABCD  EF   )
RIGHT TRUNCATED = (   ABCD  EF)
LEFT SHIFTED BY 4 = (BCD  EF    )
RIGHT SHIFTED BY 6 = (      ABCD )
```

Listing 2: *Program and run showing the packed-decimal mathematics function. The numbers must be saved into strings, then converted into packed decimal by the proper command. One may initialize precision up to 500 places; however, the more places you specify, the slower the operation will become. When the answer arrives, it is converted back to a string for printing or further normal mathematics functions. The precision of the exponent printed out in the answer is also initialized to either 10^{-64} to 10^{63} or 10^{-32768} to 10^{32767}.*

```
10 CLS:DEFINTC
20 CLEAR2000
30 N$ = "1":X$ = "3994949"
40 J = &BPRC(120,2):'SETS UP 120 DECIMAL PLACES PRECISION
50 '         + OR  - 32767 EXPONENT RANGE
60 N$ = &BCP$(N$):X$ = &BCP$(X$):'CONVERTS X$ + N$ PACKED
    DECIMAL
70 A$ = &BDP$(N$,X$):'  DIVIDES A$ BY X$ PACKED DECIMAL
80 N$ = &BPC$(A$):'CONVERT ANSWER TO PRINT
90 PRINT"1/3994949 =    ";:PRINTN$:'PRINTS ANSWER
99 END

RUN
1/3994949 =  2.50316086638402642937369162910465189918 5696
73855661236222604443761359656906759009939801484324330548
39999209001166222647 64D-00007
```

Text continued from page 96:
The extra commands available handle functions that, if done as a routine in standard BASIC, would take up to fifty times longer. The commands provide capabilities for matrix and string manipulation, graphics, and data compression.

There are twenty-three commands in the matrix category. Some of the many functions that they speed up are copying, scaling, solving simultaneous linear equations, matrix inversion, and operations on a matrix from constants or another matrix.

The speed of these commands is far superior to conventional BASIC. For instance, if you want to invert a 10 by 10 matrix, the command is J=&MINV(A,B,C), where A is the matrix to be inverted, B is the array where the inverted matrix is to be stored, and C is the size of the matrix to be inverted (default is the dimension of A), J is the return argument. J is 0 if a solution is found and −1 if not. The command A=&MINV(A,B,3) is certainly much faster to execute and requires less syntax than standard BASIC commands. For another example, suppose you want to multiply matrix A by matrix B. This is performed by the simple statement J=&MELM(A,B). All matrix commands are of similar format, execution time, and simplicity.

There are fourteen string-compression routines, which are extremely useful for compressing data for increased storage efficiency. However, you must know the type of data with which you are dealing and exactly what you intend to do to the data in the program. You can compress or expand in 4-, 5-, 6-, or 7-bit formats. You can use this in random-file formats but not in sequential files (since some control characters may be in the data). You can also convert data to lowercase or uppercase and remove multiple characters.

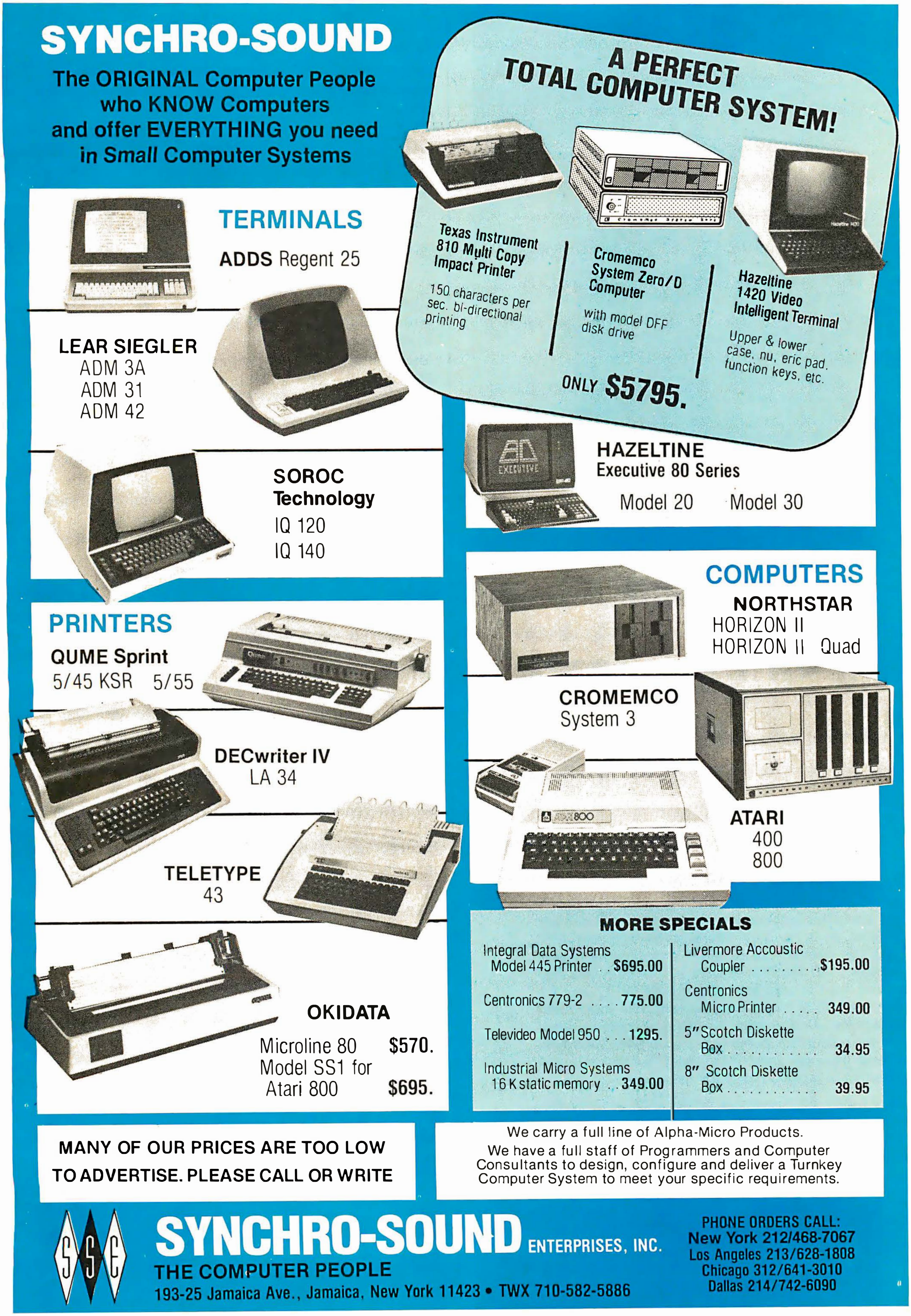
There are fourteen string-manipulation commands provided, and they handle left and right character shifting and rotating, justifying, and truncating. You can also invert a string, sort a string (multiple-key sort), delete a substring, pack string text, and more. (See listing 1, page 98, for an example.)

The graphic commands allow drawing and erasing lines between any two coordinate points. Four commands allow scrolling of the screen up, down, left, or right. There is no wraparound feature, so scrolling up and down will result in a loss of what was at the top or bottom of the screen. These commands can best be used to improve screen presentation of data, and fast execution means little time is lost.

Other available commands include the writing of matrix data onto tape and the transfer of string and variable arguments to a subroutine in the program and back again. There are decimal-to-hexadecimal conversion commands.

Infinite Business

Infinite Business is an add-on package giving twenty commands that, among other things, control a printer, provide multiple-precision mathematics, search string arrays for matching elements, and provide hash number generation. (The package needs Infinite BASIC before it will work.)


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I found the automatic page headings and pagination to be the most helpful feature in the printer category—just define the header or footer and run the program. This feature can be turned on or off and reset within the program.

I have found that packed-decimal mathematics is very interesting to most people who have Infinite Business. With it, they can add, subtract, multiply, and divide with up to 500 significant places of precision. I would have liked to have seen some more mathematics functions here such as squares, square roots, logarithms, and other technical-mathematics functions. (See listing 2, page 98, for an example.)

Conclusions

- In checking over these packages, I saw two problems. In trying to assemble an Infinite BASIC module for use in low memory on tape, I set an upper limit of hexadecimal 7FFF and the assembler bombed out. I assume this is a result of the assembler placing its code in the same memory that I had specified during the assembly process, thus clobbering the disk operating system. It is unfortunate that the assembler cannot make the object modules in high memory and save them on tape or disk. If this were so, the object modules could then be loaded into the memory locations the user specified. As it is, the assembler will save the object code to tape, but saving to disk requires typing in a cumbersome dump command. The assembler gives everything needed to type for this dump, but it would be much easier if the user did not have to intervene (and if the disk operating system clobbering were eliminated).
- The second problem is that the setting of memory size is difficult for those BASIC programmers who are not especially familiar with machine language. The Infinite BASIC documentation spends little time with examples of how to do this with user-created object modules.
- The Infinite BASIC documentation is about as difficult to understand as the Radio Shack Level II manual. There are three manuals. Two are for Infinite BASIC—one being a general description with lots of examples, the other a definition of the command formats. The Infinite Business manual has both of these elements incorporated into one volume. All the information is there, but there are not enough examples to cover every case, so the result may be that the 100 available commands will be hard for the less experienced programmer to understand. As the command statements are fairly involved, frequent references to the manuals are necessary.
- These packages would be of great help to the more skilled business, game, and general programmer who could best understand and make use of the available power. However, in comparing these to other similar packages, almost anyone would find enough of the 100 commands useful to make it worth the price. ■

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The Micromodem II data communications system and the Apple II* computer. What better combination to maximize the capabilities of your personal computer!

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The Micromodem II consists of two parts. One part includes the printed circuit board which holds the Micromodem II, ROM firmware and the serial interface. The board plugs directly into the Apple II providing all the functions of a serial interface card plus programmable auto dialing and auto answer capabilities. The on-board ROM firmware enables the Micromodem II to operate in any of three modes to perform different tasks-terminal mode, remote console and program control mode.

The other part of the Micromodem II datacomm system is a Microcoupler which connects the Micromodem board and Apple II to a telephone line. The Microcoupler gets a dial tone, dials numbers, answers the phone and hangs up when a transmission is over. There are none of the losses or distortions associated with acoustic couplers. The Microcoupler is compatible with any North American standard telephone lines and is FCC-approved for direct connection in the U.S. It works with standard dial phone service or Touch-tone service.

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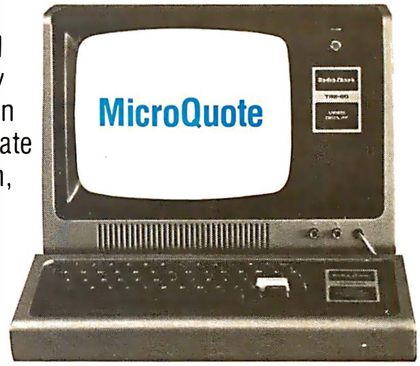


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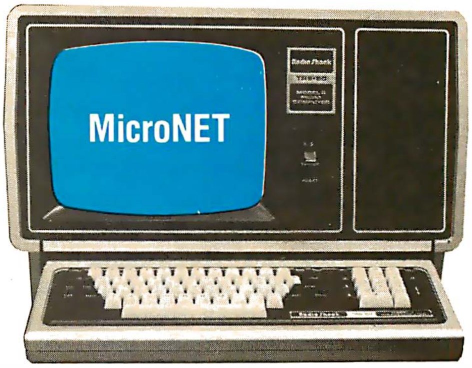


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A Pascal Library Unit for the Micromodem II

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The Micromodem

The Hayes Microcomputer Products Micromodem II is a powerful combination of hardware and firmware that facilitates computer-to-computer communication. The onboard ROM (read-only memory) contains programs for originating and answering calls (including dialing the telephone) and an ACIA (asynchronous communications interface adapter) device for parallel-to-serial conversion. In addition, the accompanying owner's manual provides a wealth of information on how to custom program the modem for such applications as repertoire dialing, modifying hardware defaults, and dumb terminal communications. All of the examples given are in BASIC.

At the time I purchased a Micromodem for my Apple II computer, Pascal software for driving it was not available. In fact, certain parts of the modem's firmware refer to locations and routines used by the old Apple monitor; these routines are accessible from BASIC but don't exist under Pascal. Having forsworn BASIC and being faced with the modem as my only non-Pascal application, I was determined to develop a suitable library of Pascal programs. With a little help from the friendly folks at Hayes Microcomputer Products (who are about to release their own Pascal software), and through close study of the manual, I was able to do just that.

About the Author: *Thomas H Woteki has a PhD in statistics and is currently developing an interactive statistics package for the Apple II. His interests include applications programming in Pascal and systems development for the Apple II.*

The Library Unit

The routines are housed in an intrinsic unit dubbed "micromodem" (see listing 1). Library units are a UCSD addition to Pascal; commonly used routines can be stored in a library unit that can be called by any Pascal program. Intrinsic units have the advantage that the object code of the unit is never entered into the code file of the host program, thereby maximizing disk storage space. A slight disadvantage is that the library containing the unit must be on-line (available for access) whenever the host program is executed. I have the unit stored in my system library on the boot disk.

UCSD Pascal units consist of two major syntactical components: an "interface" block and an "implementation" block. The interface block contains the declarations for all the structures available to the calling program, just as if they were declared in the global-data segment of that program. The implementation portion contains declarations used by the unit but not available to the host, as well as definitions of all the procedures declared in the interface. All "external" procedures (the independently assembled machine-language programs used by the unit) must be declared at this point and linked in later.

Our interface block begins with the declaration of several constants which correspond to the addresses of certain locations in the modem's ROM and the Apple's memory. The constants are appropriate to having the modem card in slot 2 on the Apple's motherboard. This is the set-up expected by the Apple's low-level I/O (input/output) drivers, the BASIC I/O Subsystem, or BIOS. If you wish to install the card in another slot you will have to modify the addresses and the BIOS accordingly.

The values "acia" and "modem" are the addresses of the ACIA and the modem control and status words, respectively. Both of these registers (actually pairs of registers) have the property that what is written to them (the control word) is not what may be read from them (the status word). Since it is important to know what was last written as the modem control word, a copy of this data is stored in location "modemcopy" in a portion of the Apple's memory.

The value "keybde" is the address of the Apple's keyboard, and "datain" is the address where characters received by the modem can be found. The value for "outa" is the address of a routine in the modem's firmware which transmits characters; this routine expects to find the characters in "dataout". Fortunately, the output routine does not reference any "old" monitor locations.

The constants "resetflag" and "selftest" correspond to two special bits in the modem control word. Setting bit 3 of the word puts the modem into the self-test mode, wherein the modem communicates with itself. Setting bit 4 prevents the ROM from automatically applying default settings to the ACIA.

The next two sets of declarations establish two variables, "br" and

"md", that may assume the values "low" (corresponding to 110 bps [bits per second]) and "high" (300 bps), and "answer" and "originate" respectively. Following this is a set of declarations for boolean-valued functions that report on various aspects of ACIA and modem status. The integer-valued functions "aciastatus" and "modemstatus" return a complete status report. The interface block concludes with a series of procedure declarations for setting the ACIA and modem control words and for performing such chores as dialing the phone, waiting for the other system to turn on its carrier, and sending and receiving characters. Several of these routines call external procedures declared in the implementation block.

The implementation block begins with a set of declarations that facilitate direct-money accessing from Pascal. The declarations establish the type "freeunion", a variant record, and a variable ("memory") of that type. The variable has two names (it is a free union; see Peter Grogono's *Programming in Pascal*, listed in the references) and will be interpreted differently depending on the name used. When referred to as "memory.addrs" it will be treated as an integer, but when referred to as "memory.pntr" it will be treated as a pointer to an array of the type "word". Thus, both the location pointed to and its contents can be manipulated from Pascal as indicated in the following fragment:

```
VAR x:0..255; (x takes integer
values from 0 to 255)

  memory.addrs:=acia; (point to
  location acia)
  x:=memory.pntr[0]; (read the
```

Text continued on page 124

Listing 1: *Library unit "micromodem" for Apple Pascal system. These routines can be called for use by any Pascal program, but they are intended to drive the Hayes Microcomputer Products Micromodem II.*

```
(*$LPRINTER:*)
(*$S+*)(* SWAPPING REQUIRED FOR UNITS *)

UNIT micromodem;INTRINSIC CODE 23 DATA 24;

  INTERFACE

    CONST datain= -16217; { $C0A7 }
          acia=   -16218; { $C0A6 }
          modem=  -16219; { $C0A5 }
          keybde= -16384; { $C000 }
          outa=   -15870; { $C202 }
          dataout=  1912; { $0778 }
          modemcopy=1658; { $067A }

          resetflag= 8;
          selftest= 16;

    TYPE  baudrate=(low,high);
          mode=    (answer,originate);

    VAR   md:mode;
          br:baudrate;

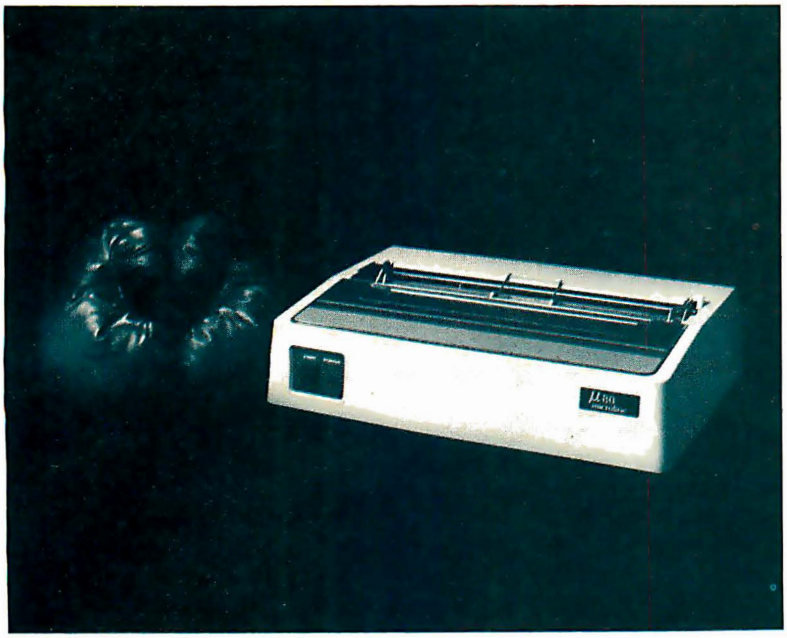
    FUNCTION ringing:BOOLEAN;
    FUNCTION carrier:BOOLEAN;
    FUNCTION rcvrfull:BOOLEAN;
    FUNCTION transempty:BOOLEAN;
    FUNCTION aciaerror:BOOLEAN;
    FUNCTION aciastatus:INTEGER;
    FUNCTION modemstatus:INTEGER;

    PROCEDURE initacia(word:INTEGER);
    PROCEDURE enabletransmit;
    PROCEDURE setmode(md:mode;br:baudrate);
    PROCEDURE pickup;
```

Listing 1 continued on page 110

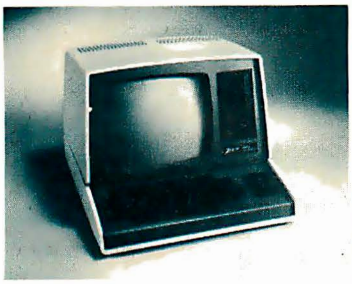
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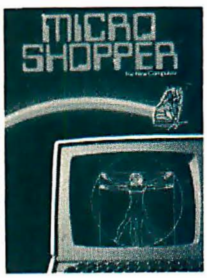
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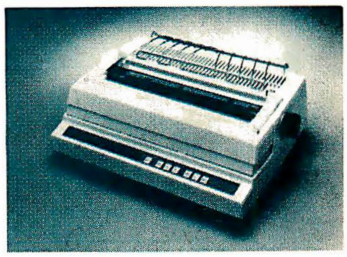
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Listing 1 continued:

```
       PROCEDURE dial(number:STRING);
       PROCEDURE waitforcarrier;
       PROCEDURE hangup;
       PROCEDURE setmodem(word:INTEGER);
       PROCEDURE sendchar;
       PROCEDURE getchar(VAR ch:CHAR);

    IMPLEMENTATION

      TYPE  word=PACKED ARRAY[0..1] OF 0..255;

            freeunion=RECORD CASE BOOLEAN OF
              TRUE:(addrs:INTEGER);
              FALSE:(value:↑word);
              END;

      VAR   memory:freeunion;

FUNCTION ringing;
  { Determine whether the phone is ringing }
  BEGIN
   memory.addrs:=MODEM;
   ringing:=memory.value↑[0]<128;
  END;

FUNCTION carrier;
  { Test for presence of carrier }
  BEGIN
   memory.addrs:=acia;
   carrier:=memory.value↑[0] MOD 8<4;
  END;

FUNCTION rcvrfull;
  { Check if ACIA receiver register is full }
  BEGIN
   memory.addrs:=acia;
   rcvrfull:=ODD(memory.value↑[0]);
  END;

FUNCTION transempty;
  { Check if ACIA transmitter register is empty }
  BEGIN
   memory.addrs:=acia;
   transempty:=ODD(memory.value↑[0] DIV 2);
  END;

FUNCTION aciaerror;
  { Check for ACIA error }
  BEGIN
   memory.addrs:=acia;
   aciaerror:=memory.value↑[0]>3;
  END;

FUNCTION aciastatus;
  { Determine ACIA status }
  BEGIN
   memory.addrs:=acia;
   aciastatus:=memory.value↑[0];
  END;

FUNCTION modemstatus;
  { Determine last value written to modem }
  BEGIN
   memory.addrs:=modemcopy;
   modemstatus:=memory.value↑[0];
  END;
```

Listing 1 continued on page 112

from 廣州 to Norwich...*



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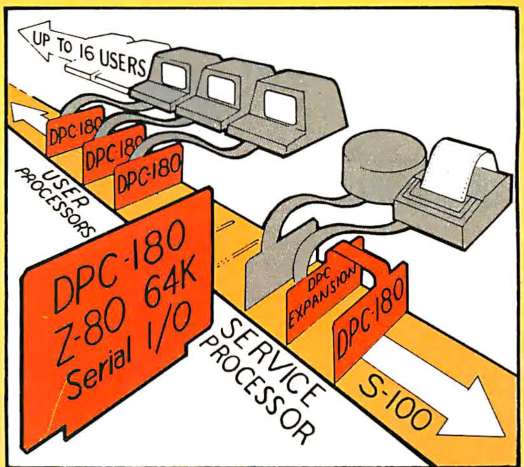
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Listing 1 continued:

```
PROCEDURE initacia;
  ( Iinitialize ACIA )
  VAR dummy:INTEGER;
  BEGIN
   memory.addrs:=acia;
   memory.value↑[0]:=3;
   memory.value↑[0]:=word;
   REPEAT dummy:=0 UNTIL NOT carrier;
  END;

PROCEDURE newmodemvalue(newbits:INTEGER);
EXTERNAL;
  ( Logical or the value last written to
     location modem (stored in modemcopy)
     with the argument, store the result
     in modemcopy and write it to modem. )

PROCEDURE enabletransmit;
  ( Turn on the modem transmitter )
  BEGIN
   newmodemvalue(2);
  END;

PROCEDURE setmode;
  ( Set the mode and baud rate )
  BEGIN
   newmodemvalue(4*ord(md)+ord(br));
  END;

PROCEDURE pickup;
  ( Pick up the phone, wait for dial tone )
  VAR dummy,wait:INTEGER;
  BEGIN
   newmodemvalue(128);
   ( wait for dial tone)
   FOR wait:=0 TO 3000 DO dummy:=0;
  END;

PROCEDURE dialit(number:STRING);EXTERNAL;
  ( Dial the indicated number, display the digits
     as they are dialed )

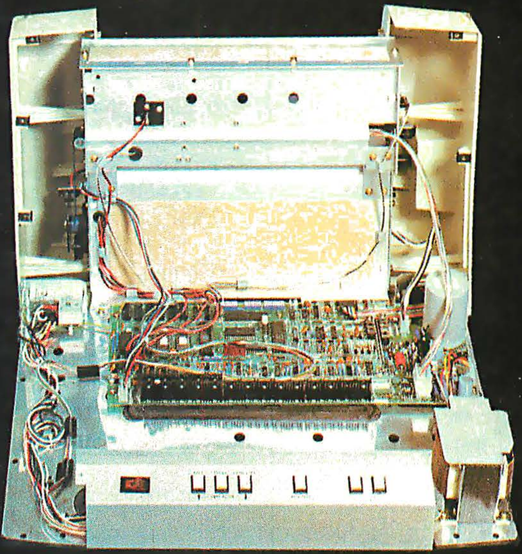
PROCEDURE dial;
  ( Dial the indicated number )
  BEGIN
   WRITE('Dialing...');
   dialit(number);
   writeln;
  END;

PROCEDURE waitforcarrier;
  ( Wait for carrier after dialing )
  VAR data,wait:INTEGER;
  BEGIN
   wait:=0;
   WHILE NOT carrier AND (wait<10000) DO
    BEGIN
     wait:=wait+1;
     memory.addrs:=datain;
     data:=memory.value↑[0];
    END;
  END;

PROCEDURE setmodem;
  ( Write a new value to the modem
     control word )
```

Listing 1 continued on page 114

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Listing 1 continued:

```
  BEGIN
   memory.addrs:=modemcopy;
   memory.value↑[0]:=0;
   newmodemvalue(word);
  END;

PROCEDURE hangup;
  ( Hang up the phone, turn off the modem )
  BEGIN
   setmodem(0);
  END;

PROCEDURE sndchar;EXTERNAL;
  ( Get a character from the keyboard,
     transfer it to the modem output lo-
     cation dataout, and transmit the
     character via the modem routine
     located at outa )
PROCEDURE sendchar;
  BEGIN
   sndchar;
  END;

FUNCTION gtchar:CHAR;EXTERNAL;
  ( Fetch the character stored in the
     modem input location datain and
     send it to the screen. Pass the
     character as a function result. )
PROCEDURE getchar;
  BEGIN
   ch:=gtchar;
  END;

BEGIN
 setmodem(resetflag);
END.
```

Listing 2: *The assembly-language programs called in the implementation block of listing 1. These low-level utility routines are stored as part of a file called NATIVECODE in a library unit, and may be accessed from any Pascal program.*

```
;++++++++++++++++++++++++++++++++++++++++
;
;  THESE ROUTINES ARE STORED IN THE
;  SYSTEM LIBRARY:
;
;     POKE(VALUE,ADDRS:INTEGER);
;     PEEK(ADDRS:INTEGER):INTEGER;
;     CALL(ADDRS:INTEGER);
;     DIALIT(NUMBER:STRING);
;     NEWMODEMVALUE(WORD:INTEGER);
;     SNDCHAR;
;     GTCHAR;
;
;
;    THOMAS H.WOTEKI
;    LAST UPDATE MAY 1980
;-----------------------------------------

        .MACRO POP
        PLA
        STA %1
        PLA
        STA %1+1
```

Listing 2 continued on page 116

Listing 2 continued:

```
        .ENDM

        .MACRO PUSH
        LDA %1+1
        PHA
        LDA %1
        PHA
        .ENDM

        ;GLOBAL EQUATES
PASCAL    .EQU 00
PASCALHI  .EQU 01
BIOSIN    .EQU 0C083
BIOSOUT   .EQU 0C08B
CONCHECK  .EQU 0D681
VIDOUT    .EQU 0D7E7

;=====================================
;
        .PROC POKE,2 ;2 PARAMETER WORDS
;
;PROCEDURE(VALUE,ADDRS:INTEGER)
;
;  EFFECT:
;
;    VALUE IS STORED AT ADDRS
;
;-------------------------------------
ADDRS     .EQU 02
ADDRSHI   .EQU 03
        POP PASCAL

        LDY #00          ;INITIALIZE Y-REG

        POP ADDRS        ;SAVE ADDRESS
                         ;ARGUEMENT

        PLA              ;LSB OF VALUE
        STA @ADDRS,Y     ;STORE VALUE AT
                         ;ADDRS
        PLA              ;DISCARD MSB VALUE

        PUSH PASCAL
        RTS              ;BACK TO PASCAL

;=====================================
        .FUNC PEEK,1 ;1 PARAMETER WORD
;
;FUNCTION PEEK(ADDRS:INTEGER):INTEGER
;
;   EFFECT:
;
;     THE CONTENTS OF ADDRS ARE
;     RETURNED BY PEEK
;
;-------------------------------------
ADDRS     .EQU 02
ADDRSHI   .EQU 03
        POP PASCAL

        PLA              ;DISCARD 4 BYTES
        PLA              ;OF STACK BIAS
        PLA              ;ASSOCIATED WITH
        PLA              ;FUNCTIONS

        POP ADDRS        ;SAVE ADDRESS TO
                         ;PEEK
```

Listing 2 continued on page 118

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Listing 2 continued:

```
        LDA #00         ;INITIALIZE
        TAY             ;Y-REG
        PHA             ;PUSH MSB OF
                        ;RETURNED VALUE:
                        ;ZERO

        LDA @ADDRS,Y ;LOAD A WITH LSB
                        ;OF RETURN VALUE
        PHA             ;PUSH ON STACK

        PUSH PASCAL
        RTS             ;BACK TO PASCAL


;=======================================
        .PROC CALL,1; 1 PARAMETER WORD
;
;PROCEDURE CALL(ADDRS);
;
;   EFFECT:
;     CALLS THE ROUTINE LOCATED AT ADDRS
;    AND RETURNS TO PASCAL
;
;USES A FORM OF INDIRECT ADDRESSING
;SUGGESTED BY KENNETH SKIER IN THE JAN
;1980 OF BYTE, P. 118.:
;
;A JSR INSTRUCTION FOLLOWED BY "ADDRS"
;ARE LOADED INTO CONSECUTIVE LOCATIONS

;BEGINNING AT LOCATION "JUMP". CALL THEN
;EXECUTES A JSR TO THAT LOCATION THEREBY
;TRANSFERRING CONTROL TO THE ROUTINE
;LOCATED AT "ADDRS".
;
;WHEN THE RTS IN THE DESTINATION ROUTINE
;IS ENCOUNTERED, CONTROL IS RETURNED TO
;LOCATION "DONE", THEN TO THE MAIN BODY
;OF CALL, THEN TO PASCAL.

;---------------------------------------
JUMP      .EQU 02
ADDRS     .EQU 03
ADDRSHI   .EQU 04
DONE      .EQU 05

          POP PASCAL

          LDA #20
          STA JUMP
          LDA #60
          STA DONE

          POP ADDRS ;SAVES ADDRESS OF
                    ;DESTINATION ROU-
                    ;TINE
          JSR JUMP

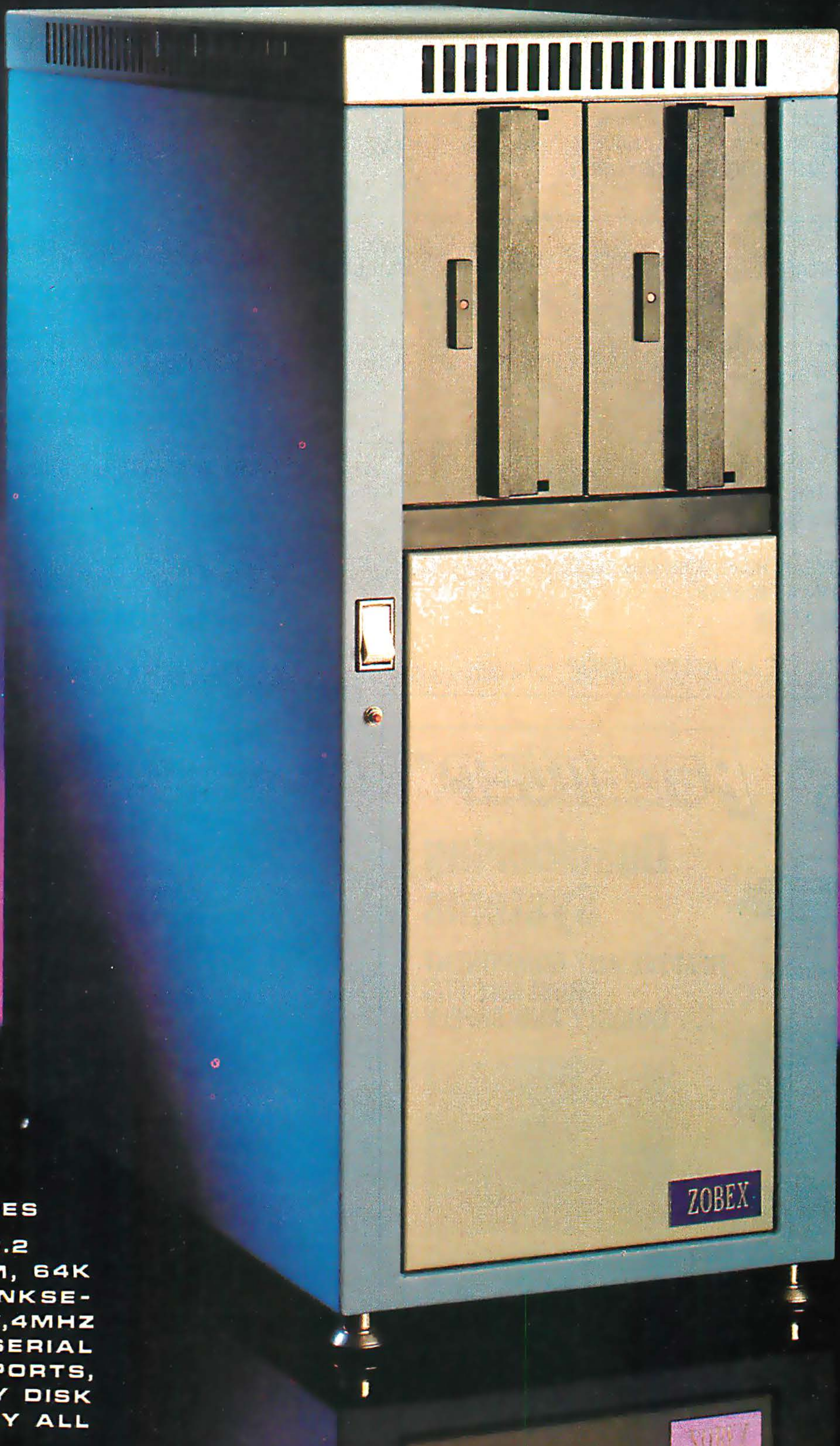
          PUSH PASCAL
          RTS

;=========================================
;

          .PROC DIALIT,1
;
; A PROCEDURE TO DIAL THE PHONE USING
```

Listing 2 continued on page 120

MULTIUSER



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Listing 2 continued:

```
; THE D.C. HAYES MICROMDEM II.
;
; THIS ROUTINE IS CALLED BY THE PROCEDURE
;
;   DIAL(NUMBER:STRING)
;
; IN THE LIBRARY UNIT MICROMDEM.
;
; THIS ROUTIINE ASSUMES THE MICROMDEM
; IS IN SLOT 2 ON THE MOTHER BOARD.
; IT SHARES "MODEMCOPY",
; WHICH CONTAINS A COPY OF THE MODEM
; CONTROL WORD, WITH THE LIBRARY UNIT.
;
;=========================================

MODEM     .EQU 0C0A5
MODEMCOPY .EQU 067A
WAIT61    .EQU 99
WAIT39    .EQU 7A
LOCATION  .EQU 02
LENGTH    .EQU 04
HANGUP    .EQU 06
PICKUP    .EQU 07

          ;SAVE THE PASCAL RETURN ADDRESS
          POP PASCAL

          ;POP THE MEMORY ADDRESS OF THE
          ;TELEPHONE NUMBER
          POP LOCATION

          ;INITIALIZE LOCATIONS HANGUP
          ;AND PICKUP FOR PROPER DIALING
          LDA MODEMCOPY
          AND #7F
          STA HANGUP
          LDA MODEMCOPY
          ORA #80
          STA PICKUP
          ;REMEMBER HOW MANY DIGITS IN
          ;THE TELEPHONE NUMBER
          LDY #00
          LDA @LOCATION,Y
          STA LENGTH

          ;INITIALIZE TO GET THE FIRST
          ;DIGIT
          LDY #01

NXTDIGIT  TYA
          PHA ;SAVE DIGIT NUMBER ON STACK
          LDA BIOSIN ;SWTICH TO BIOS
          LDA @LOCATION,Y ;DISPLAY DIGIT
          JSR VIDOUT      ;ON CONSOLE
          LDA BIOSOUT ;BACK TO PASCAL
          PLA ;RECOVER DIGIT NUMBER
          TAY
          LDA @LOCATION,Y ;GET DIGIT AGAIN

          ;CONVERT DIGIT FROM CHARATER FORM
          SEC
          SBC #30
          BNE START
          LDA #0A   ;IN CASE DIGIT IS 0

          ;INITIALIZE X TO COUNT PULSES
START     TAX

          ;DIAL THE DIGIT
PULSE     LDA HANGUP
          STA MODEM
          LDA #WAIT61
          JSR WAIT
          LDA PICKUP
          STA MODEM
          LDA #WAIT39
          JSR WAIT
          DEX
          BNE PULSE

          ;WHEN DONE WITH A DIGIT CHECK
          ;TO SEE IF DONE WITH NUMBER

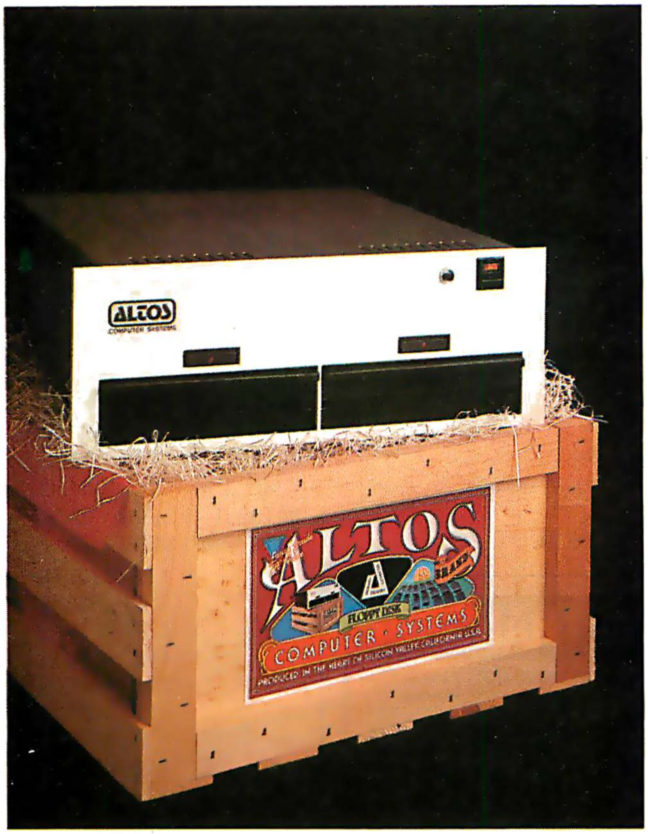
          CPY LENGTH
          BEQ DONE
          ;IF NOT, WAIT A WHILE THEN GET
          ;THE NEXT DIGIT
          JSR LONGWAIT
          INY
          BPL NXTDIGIT

DONE      PUSH PASCAL
          RTS

LONGWAIT  LDX #05
AGAIN     LDA #0FF
          JSR WAIT
          DEX
          BNE AGAIN
          RTS
```

Listing 2 continued on page 122

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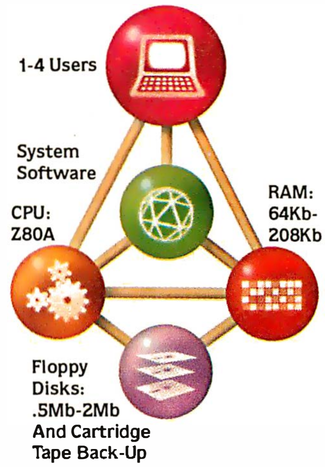
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Circle 76 on inquiry card.

Listing 2 continued:

```
WAIT    SEC
WAIT2   PHA
WAIT3   SBC #01
        BNE WAIT3
        PLA
        SBC #01
        BNE WAIT2
        RTS

;======================================
;
        .PROC NEWMODEMVALUE,1
;
; A PROCEDURE TO CHANGE THE CONTENTS
; OF LOCATION $COA5 WHICH IS THE (SLOT
; 2) LOCATION OF THE MICROMODEM CONTROL
; WORD. THIS IS A ROUTINE WRITTEN ESPE-
; CIALLY FOR USE BY THE LIBRARY UNIT
; MICROMODEM.
;
; THE ROUTINE LOGOCAL ORS ITS ARGUMENT WITH
; THE CONTENTS OF MODEMCOPY, $067A, SAVES
; THE RESULT IN MODEMCOPY AND WRITES IT TO
; MODEM, $COA5.
;--------------------------------------
MODEMCOPY  .EQU 067A
MODEM    .EQU 0C0A5

         POP PASCAL


         ;PULL THE VALUE OF THE NEW
         ;BITS TO BE SET AND UPDATE
         ;MODEM
         PLA
         ORA MODEMCOPY
         STA MODEMCOPY
         STA MODEM

         PLA        ;DISCARD MSB OF
                    ;NEWBITS

         ;BACK TO PASCAL
         PUSH PASCAL
         RTS

;======================================
;

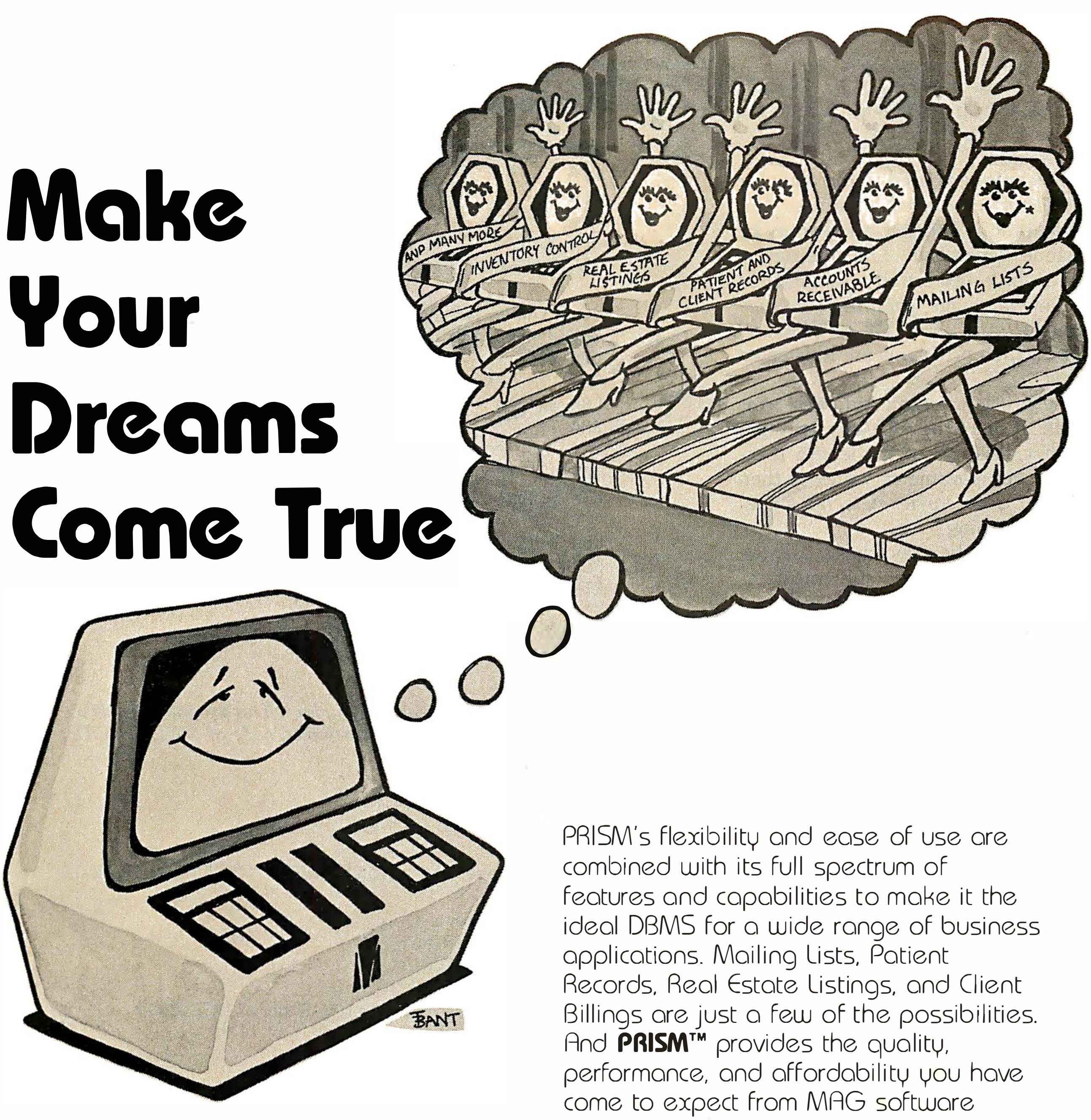
         .PROC SNDCHAR
;
; APROCEDURE TO OUTPUT ONE CHARACTER
; THROUGH THE MICROMODEM LOCATED IN
; SLOT 2.
;
; ROUTINE IS CALLED FROM THE LIBRARY
; UNIT MICROMODEM.
;
;--------------------------------------
RPTR     .EQU 0BF18
WPTR     .EQU 0BF19
CONBUF   .EQU  03B1
BUMP     .EQU 0D72C
DATAOUT  .EQU  0778
OUTA     .EQU 0C202
         LDA BIOSIN
         JSR CONCHECK
         LDX RPTR
         CPX WPTR
         BEQ HOME
         JSR BUMP
         STX RPTR
         LDA CONBUF,X
         STA DATAOUT
         JSR OUTA
HOME     LDA BIOSOUT
         RTS

;======================================
;
         .FUNC GTCHAR
;
; A ROUTINE TO GET ONE CHARACTER FROM
; THE MICROMODEM DATA INPUT LOCATION
; DATAIN. THE ROUTINE ASSUMES THE RE-
; CEIVER REGISTER IS FULL.
;
; AFTER FETCHING THE CHARACTER THE ROU-
; TINE OUTPUTS IT TO THE CONSOLE SCREEN
; AND RETURNS THE VALUE TO THE CALLING
; PROGRAM AS A FUNCTION RESULT.
;
; THIS ROUTINE IS PART OF THE LIBRARY
; UNIT MICROMODEM.
;
;--------------------------------------
DATAIN   .EQU 0C0A7

         POP PASCAL
```

Listing 2 continued on page 124

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Text continued from page 108:

status of the acia)
memory.pntr[0]:=x; (write the acia control word)

This technique is used in the code for several of the listed routines. Implementation of the technique may be machine dependent. The alternative is to link externally assembled machine-language programs to perform the work of BASIC's PEEK and POKE. Such programs are illustrated below.

The procedure "initacia" performs initialization of the ACIA by setting it up for characters of the length specified by the parameter value. It then waits for a *no-carrier-detected* signal before returning.

Several of the procedures call the external procedure "newmodemvalue" which is used to set selected bits in the modem control word to logical 1 without affecting the status of any other bits. By contrast, "setmodem" sets all bits (except the selected ones) to logical 0.

Procedure "waitforcarrier" waits a period of time to detect a carrier after dialing the phone. Unloading the location "datain" in the WHILE...DO loop is necessary to satisfy the ACIA, as suggested on pages 38 and 39 of the owner's manual.

The procedures "sendchar" and "getchar" are Pascal hosts for calling the external procedures "sndchar" and "gtchar" which are the workhorses for simple modem I/O. "Getchar" passes the character it gets to the calling program via the variable parameter "ch" in case the user wishes to process "ch" further (say, by sending it to the system printer). I have done this to retain printed copy of terminal sessions.

The statement "setmodem (resetflag);" in the body of the unit will be executed as an initialization step when the host program is executed. Setting the reset flag informs the ACIA that default initializations are not to be applied when the ACIA is first called for input or output.

The External Procedures

The assembly-language programs called in the implementation block of the unit (see listing 2) are part of a file called NATIVECODE. I have stored these and other low-level utility routines, such as the PEEK and POKE routines, in a library unit. Therefore they can be called from any of my

Listing 2 continued:

```
PLA ;DISCARD 4 BYTES OF FUNC-

PLA ;TION BIAS
PLA
PLA

LDA BIOSIN
JSR CONCHECK

;GET CHARACTER AND
;PUSH FUNCTION RESULT
LDA #00
PHA
LDA DATAIN
PHA

;OUTPUT TO CONSOLE
JSR VIDOUT

LDA BIOSOUT
PUSH PASCAL
RTS

.END
```

Listing 3: *The Pascal program called "fullduplex". This program makes use of the compiled code of the unit, linked with the assembled code of NATIVECODE.*

```
PROGRAM fullduplex;

USES micromodem;

 FUNCTION peek(location:INTEGER):INTEGER;EXTERNAL;

 PROCEDURE dialup;
 VAR number:STRING;
     word:INTEGER;

  PROCEDURE setaciacntrl(VAR word:INTEGER);
  BEGIN
   REPEAT
    page(output);
    gotoxy(0,3);
    writeln('Select the ACIA control word:');
    writeln;writeln;
    writeln('CHAR    PARITY  STOP  CONTROL');
    writeln('LENGTH  BIT     BITS   WORD  ');
    writeln('-----------------------------');
    writeln('  7     EVEN     2        1');
    writeln('  7     ODD      2        5');
    writeln('  7     EVEN     1        9');
    writeln('  7     ODD      1       13');
    writeln('  8     NONE     2       17');
    writeln('  8     NONE     1       21');
    writeln('  8     EVEN     1       25');
    writeln('  8     ODD      1       29');
    writeln;
    write('ACIA control word--> ');
    readln(word);
   UNTIL word IN [1,5,9,13,17,21,25,29];
  END; { setcntrlword }


 BEGIN { dialup }
  setmodem(resetflag);
```

Listing 3 continued on page 126

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Pascal programs. As mentioned above, when appropriate, POKE and PEEK can be substituted whenever the variable "memory" is used to address memory.

When a call-by-value is made to an external procedure using scalar parameters, the Pascal interpreter places the values of the parameters on the stack in reverse order of declaration in the procedure, followed by the Pascal return address. External functions have 4 additional bytes added to the stack before the Pascal address. When a call-by-variable (or a call-by-value using nonscalar parameters) is made, a pointer to the variable is loaded on the stack. The difference in these calls is illustrated in the definitions of POKE, PEEK, and DIALIT.

The declarations for NATIVE-CODE start with the definitions for two *macros* and several *global equates*; these declarations are available to all the routines in the file. One macro pops (removes) 2 bytes from the stack (this implementation of Pascal is 2-bytes-per-word oriented) and saves them in successive locations specified by the parameters in the call; the other macro reverses this.

The global equates BIOSIN and BIOSOUT establish the addresses of two soft switches for gaining access to the Apple's BIOS. One reference to BIOSIN switches it into programmable memory while two successive references enable writing to the BIOS section of memory; a reference to BIOSOUT switches the BIOS out and the Pascal interpreter in. The declaration for CONCHECK establishes it as the starting address in the BIOS for the routine that polls the Apple's keyboard. VIDOUT is the address of the routine for displaying characters on the video monitor.

The procedure DIALIT illustrates call-by-value with a nonscalar value: a pointer to the number to be dialed is passed to the program. After storing the pointer, the routine prepares to dial by setting the temporary locations HANGUP and PICKUP and finding the length of the number. Dialing is accomplished by alternating the phone between the onhook and offhook states. (We assume the phone is off the hook when the routine is called.) The recommended dialing protocol is 61 ms onhook followed by 39 ms offhook with an interdigit delay of at least 600 ms.

The procedure SNDCHAR is used

Listing 3 continued:

```
  page(output);
  gotoxy(0,5);
  writeln('Enter the phone number.');
  writeln;
  write('      --> ');
  readln(number);
  setaciacntrl(word);
  page(output);
  gotoxy(0,5);
  write('Preparing to dial, please wait...');
  initacia(word);
  pickup;
  setmode(originate,high);
  writeln('OK');
  dial(number);
  writeln;
  writeln('Waiting for carrier...');
  waitforcarrier;
 END;

 PROCEDURE terminal;
 VAR ch:CHAR;
     error:INTEGER;

 BEGIN
  page(output);
  gotoxy(0,5);
  writeln('Carrier OK. Begin communications.');
  enabletransmit;
  REPEAT
   IF aciaerror
    THEN IF NOT carrier
          THEN BEGIN
                hangup;
                unitclear(1);
                exit(terminal);
               END
          ELSE BEGIN
                write('#');
                error:=peek(datain);
               END
    ELSE IF rcvrfull
          THEN getchar(ch)
          ELSE sendchar;
  UNTIL NOT carrier;
 END;

 FUNCTION tryagain:BOOLEAN;
 VAR answr:CHAR;
 BEGIN
  REPEAT
   page(output);
   gotoxy(0,5);
   write('No carrier. Try again? (Y/N)->');
   read(answr);
   writeln;
   tryagain:=answr IN ['Y','y'];
  UNTIL answr IN ['Y','N','y','n'];
 END;

BEGIN { fullduplex }
 REPEAT
  dialup;
  IF carrier
   THEN terminal;
 UNTIL NOT tryagain;
 hangup;
END.
```

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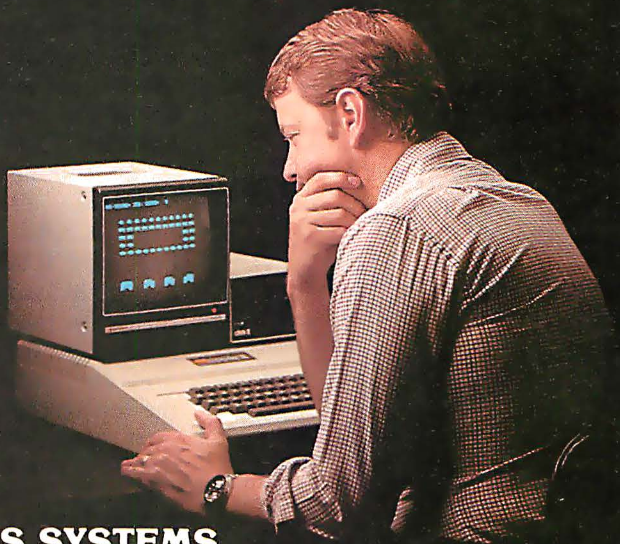
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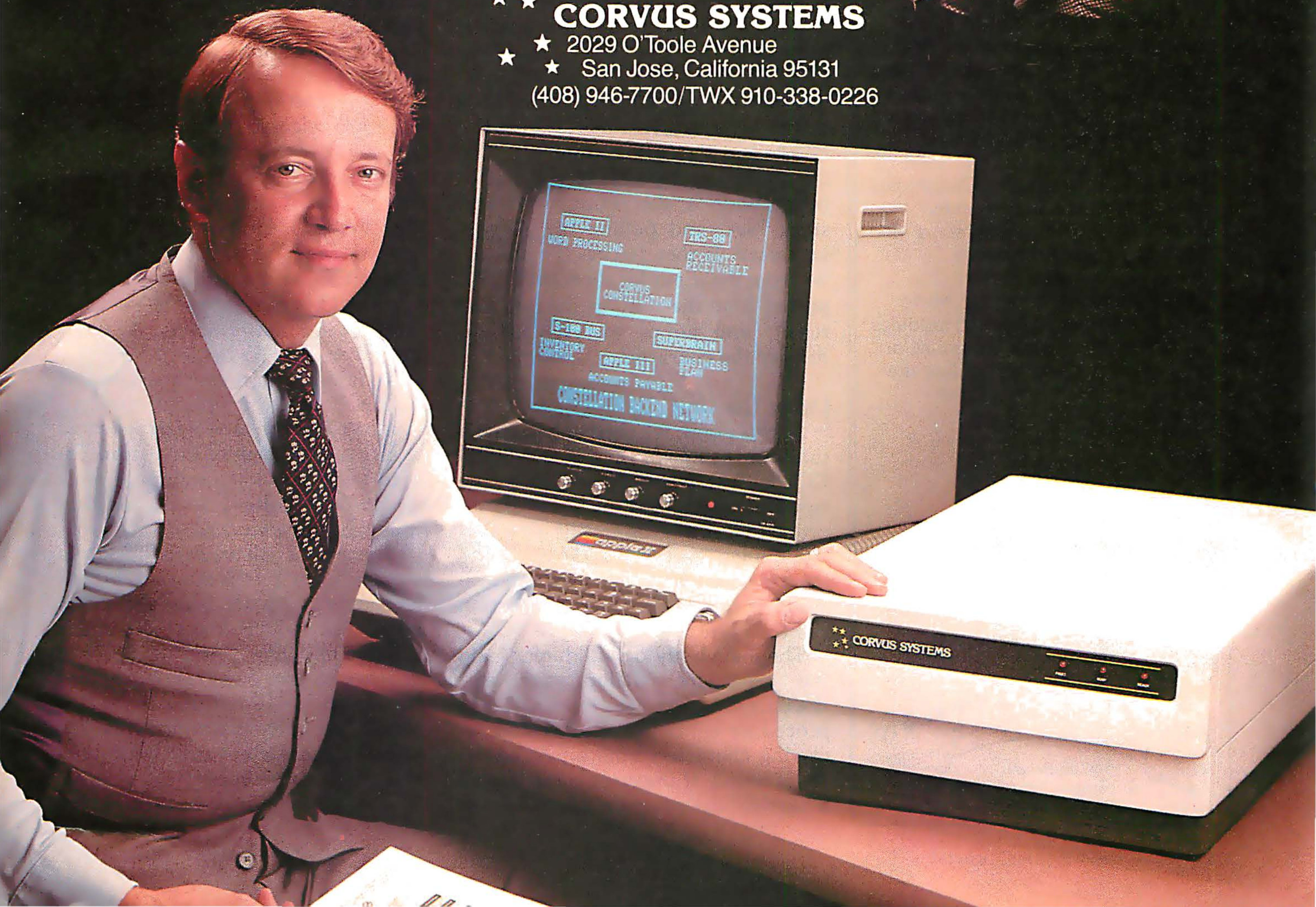
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to transmit characters through the modem. It does not check to see if the ACIA transmitter register is empty; this should be done in the calling program using "transempty". Location CONBUF is the start address for the BIOS's console keyboard buffer, and WPTR and RPTR indicate the number of characters written to and read from the buffer. BUMP is the address of a routine that updates these numbers.

SNDCHAR first polls the console keyboard. If there is a character in the buffer, it loads it into DATAOUT, then calls the output routine on the modem. At the end of all this, the address for returning to Pascal is still on the top of the stack, so an RTS (return from subroutine) instruction transfers control to the calling program.

In GTCHAR, VIDOUT is the address of the BIOS routine for sending characters to the video monitor. GTCHAR (analogous to SNDCHAR) assumes the ACIA's receiver register is full, a condition that should be checked in the calling program. The routine starts by saving the Pascal return address, discarding 4 bytes of stack bias, and polling the Apple's keyboard. It then fetches the character from the input location DATAIN, pushes it on the stack as the function result, and jumps to VIDOUT to display the character.

Using the Unit

At this point, we need only compile the unit, assemble the file NATIVECODE, link the two, and store the resulting final code in a library in order to use the unit. The program "fullduplex" (see listing 3) illustrates the use of the unit. The program also makes a call to the external function PEEK.

The main body of "fullduplex" and the procedure "dialup" are self-documenting. As for "terminal", the procedure continues sending and receiving characters until an ACIA error is found. If the error is the lack of a carrier, the program hangs up the phone, clears the keyboard buffer of any junk, and exits "terminal" to "tryagain". If any other error is encountered, the character "#" is written to the video display and the receiver register is emptied to clear the error condition. I have used this program to communicate with several time-sharing systems and it has no problem keeping up at 300 bps.

Modifying the Apple's BIOS

The procedures presented thus far are quite adequate for a variety of dumb terminal applications, but they are not particularly well suited to mass-data transfer applications such as transmitting preprocessed files or whole volumes. For the latter, we would like to make use of the repertoire of UCSD Pascal intrinsic procedures for processing files. The key to using these procedures is an understanding of the BIOS (basic input/output system).

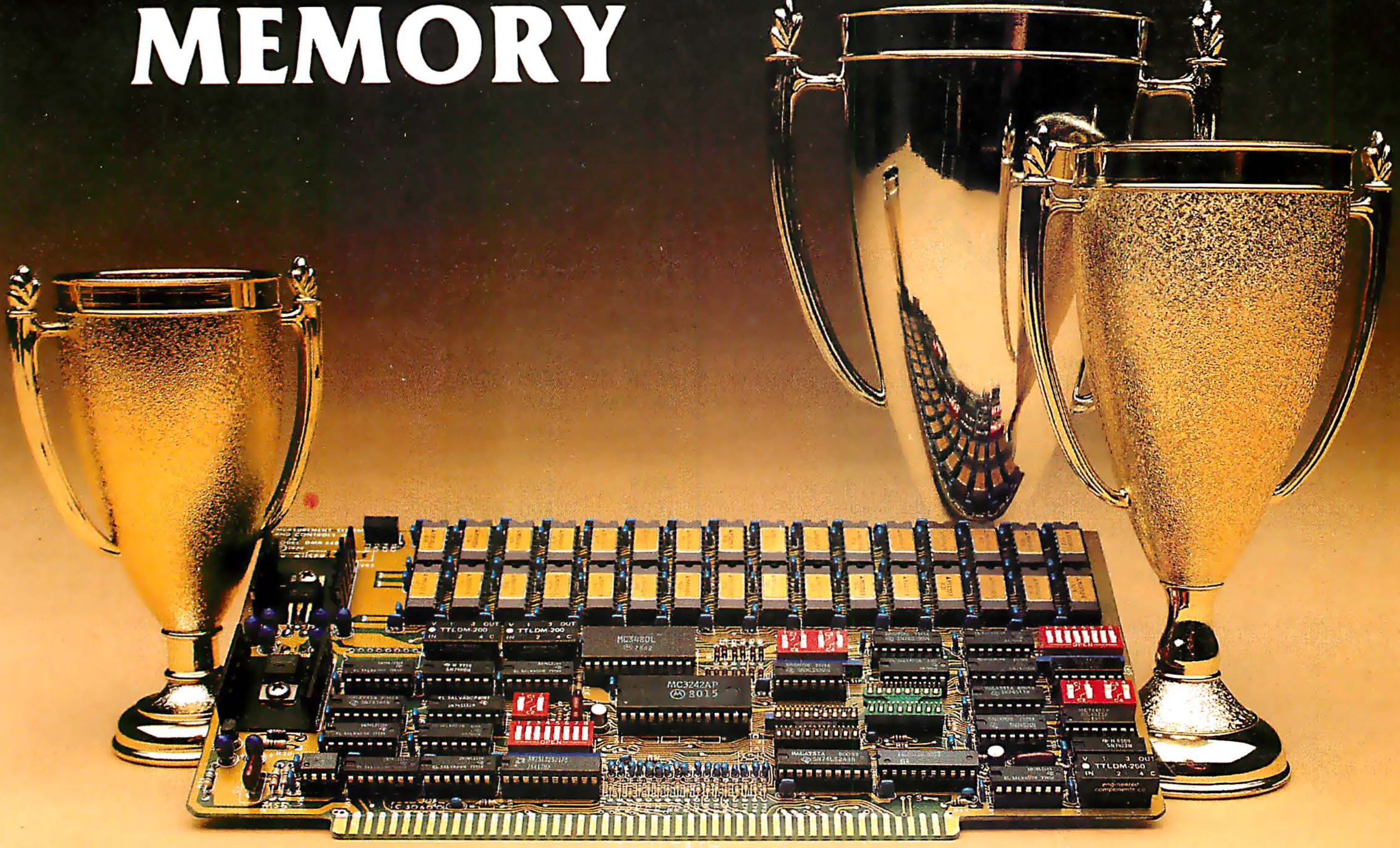
Each implementaton of UCSD Pascal, such as Apple's, requires an interpreter and a BIOS to support it. Roughly speaking, the interpreter translates p-code (the code emitted by the Pascal compiler) into machine language, and the BIOS handles the physical I/O to system devices. The BIOS modifications discussed below apply only to the Apple and may require revision if new versions of the BIOS are released. Hints on modifying another system's BIOS may perhaps be found in the *UCSD Pascal User's Manual* published by SofTech Microsystems. However, it is likely you will need a commented listing of your BIOS; I obtained a copy of the Apple BIOS from Apple in the form "The Preliminary Guide to Interfacing Foreign Hardware."

To fully explain the operation of the BIOS and the options the programmer has for modifying it would require a great deal of discussion. Instead I will provide a summary of its operation and offer a set of modifications that have worked for me.

Whenever a call for input or output is made from a Pascal program, the interpreter formats the data and determines which device is being called. Following this, the BIOS is switched in and then determines how the device is interfaced with the system. As currently configured, the Apple's interpreter and BIOS can recognize four types of external

Text continued on page 136

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Listing 4: *External procedure that modifies Apple BIOS for use with the Micromodem II. This expands the Apple's utility beyond that of a dumb terminal, allowing mass transfer (and processing) of whole files via the Micromodem II.*

```
;=======================================
;

          .PROC SYSGEN
;
;
;---------------------------------------
BIOSIN    .EQU 0C083
BIOSOUT   .EQU 0C08B
CONCHECK  .EQU 0D681
ACIA      .EQU 0C0A6
DATAOUT   .EQU 0778
DATAIN    .EQU 0C0A7
MODEM     .EQU 0C0A5
OUTA      .EQU 0C202
ICOM      .EQU 0D7A3
RINIT     .EQU 0D79C
RWRITE    .EQU 0D809
WCOM      .EQU 0D81F
RCOM      .EQU 0D85D
RREAD     .EQU 0D84E

          LDA BIOSIN
          LDA BIOSIN

          LDY #00
XRINIT    LDA PRG2,Y
          STA RINIT,Y
          INY
          CPY #03
          BCC XRINIT

          LDY #00
XICOM     LDA PRG3,Y
          STA ICOM,Y
          INY
          CPY #0A
          BCC XICOM

          LDY #00
XRWRITE   LDA PRG4,Y
          STA RWRITE,Y
          INY
          CPY #06
          BCC XRWRITE

          LDY #00
XWCOM     LDA PRG5,Y
          STA WCOM,Y
          INY
          CPY #11
          BCC XWCOM

          LDY #00
XRREAD    LDA PRG6,Y
          STA RREAD,Y
          INY
          CPY #03
          BCC XRREAD
```

Listing 4 continued on page 132

Listing 4 continued:

```
          LDY #00
XRCOM     LDA PRG7,Y
          STA RCOM,Y
          INY
          CPY #0F
          BCC XRCOM

          LDA BIOSOUT
          RTS

PRG2      .BYTE 4C,0A3,0D7 ;JMP ICOM

PRG3      .BYTE 0A9,03      ;LDA #03
          .BYTE 8D,0A6,0C0 ;STA ACIA
          .BYTE 0A9,15      ;LDA #15
          .BYTE 8D,0A6,0C0 ;STA ACIA

PRG4      .BYTE 0A8         ;TAY
          .BYTE 0A2,00      ;LDX #00
          .BYTE 4C,1F,0D8  ;JMP WCOM

PRG5      .BYTE 20,81,0D6  ;JSR CONCHECK
          .BYTE 0AD,0A6,0C0;LDA ACIA
          .BYTE 29,02       ;AND #02
          .BYTE 0F0,0F6     ;BEQ WCOM
          .BYTE 8C,78,07    ;STY DATAOUT
          .BYTE 20,02,0C2  ;JSR OUTA
          .BYTE 60          ;RTS

PRG6      .BYTE 4C,5D,0D8  ;JMP RCOM

PRG7      .BYTE 20,81,0D6  ;JSR CONCHECK
          .BYTE 0AD,0A6,0C0;LDA ACIA
          .BYTE 4A          ;LSR A
          .BYTE 90,0F7      ;BCC RCOM
          .BYTE 0AD,0A7,0C0;LDA DATAIN
          .BYTE 0A2,00      ;LDX #00
          .BYTE 60          ;RTS

          .END

PROGRAM startup;

PROCEDURE sysgen;EXTERNAL;

BEGIN
 sysgen;
 gotoxy(0,5);
 writeln('Welcome to Dr. Wo's Apple Pascal!');
 writeln;
 writeln('The sytem has just been modified to');
 writeln('enable communications through the');
 writeln('Micromodem II in slot 2.');
 writeln;
 writeln('Please set the DATE using the Filer.');
END.
```

Listing 5: *A program to test the Micromodem II system. The program prompts the operator, then puts the modem through its various modes of operation.*

```
PROGRAM testmodem;

{This program tests the transmission and reception of the printing
 characters through the Micromodem II installed in slot 2 on the
  Apple's board. The program uses the Library Unit 'micromodem' and
  custom I/O drivers installed as modifications in the Apple's BIOS.}
```

Listing 5 continued on page 134

Listing 5 continued:

```
USES micromodem;

CONST lowchar= ' '; { blank }
      highchar='z';

VAR chout,chin:CHAR;
    errorcount:INTEGER;
    m:ARRAY[mode] OF STRING[10];
    b:ARRAY[baudrate] OF STRING[10];
    remin,remout:INTERACTIVE;

BEGIN { main }

 reset(remin,'remin:');
 rewrite(remout,'remout:');

 m[answer]:='answer';
 m[originate]:='originate';
 b[low]:='110 baud';
 b[high]:='300 baud';

 FOR md:=answer TO originate DO
  FOR br:=low TO high DO
   BEGIN
    page(output);
    gotoxy(0,5);
    writeln('Testing ',m[md],' mode, ',b[br]);
    writeln;writeln;
    writeln('Resetting modem and ACIA.');
    write('Please wait...');
    setmodem(selftest+resetflag);
    initacia(21);
    pickup;
    setmode(md,br);
    writeln('OK');
    writeln;

    write('Please wait for carrier...');
    enabletransmit;
    waitforcarrier;
    writeln('OK');

    writeln;
    writeln('Begin test...');
    errorcount:=0;
    FOR chout:=lowchar TO highchar DO
     BEGIN
      write(remout,chout);
      read(remin,chin);

      IF (ord(chout)-ord(lowchar)) MOD 40<39
       THEN write(chout)
       ELSE writeln(chout);


      IF chout<>chin
       THEN BEGIN
             errorcount:=errorcount+1;
             writeln('Error in sending ',chout);
            END;
     END;

    writeln;writeln;
    writeln('Total errors this test= ',errorcount);
    writeln;
    write('Type <ret> to continue...');readln;
   END;
```



Text continued from page 128:
physical devices—consoles, printers, disks, and remote input/output devices (such as modems)—provided these devices are interfaced via an Apple-brand card. For nondisk I/O, the Apple's BIOS recognizes the Apple communications, serial, and parallel-printer cards. If a foreign card is plugged into a slot, the Apple will know that something is there, but will not know how to communicate with it unless the card's setup happens to coincide with one of the Apple cards. Such is the case for the Micromodem interface: the Apple thinks it is communicating with a remote device via an Apple communications card, but it can't do I/O because of an address mismatch. The solution is to insert the correct addresses.

The Apple's BIOS is set up to do three things with the modem: initialize it, read from it, and write to it. In each case, the BIOS receives control from the interpreter, jumps to a location reserved for the appropriate operation with the remote I/O device, determines which type of card it is dealing with, then jumps to a location reserved for that combination of card and operation. After completing I/O, it returns control to the interpreter. This combination of jumps was observed in my modifications. Since I have no Apple communications cards connected to my system, I customized the locations to suit the requirements of the Micromodem. These modifications are applied at system startup time via an external procedure SYSGEN hosted by the program "startup".

The procedure SYSGEN (see listing 4) first enables writing the BIOS. Then it modifies the routine located at RINIT so that a JMP to location ICOM is made. In the unmodified BIOS, RINIT is the name of a routine for initializing the remote device: it first determines what type of card is in slot 2; after finding a communications card it jumps to ICOM to initialize the card. Under these modifications, control is transferred to ICOM immediately. SYSGEN next modifies RWRITE, the "write-to-remote" routine, and WCOM, the "write-to-comm-card" routine. Similar to the unmodified initialization routines, the interpreter passes control to RWRITE, which determines the type of card occupying slot 2. Upon finding a communications card, it transfers control to WCOM. SYSGEN closes with modifications to RREAD and RCOM.

One can implement the modifications, as I have, in a program that is executed each time the system is booted up. First assemble SYSGEN, then link it to a Pascal host "startup", and then store the final code in the file SYSTEM.STARTUP on the boot disk. The program will be executed automatically at boot time.

A Test Program

The program "testmodem" tests the modem and the BIOS modifications. It starts by opening the files "remin" and "remout" and associating them with the volumes "remin:" and "remout:" respectively. The latter are the names given to remote I/O devices under Apple UCSD Pascal. Following this procedure, the program sets up some strings to prompt the operator, and the nested FOR...DO loops put the modem through its various operating modes.

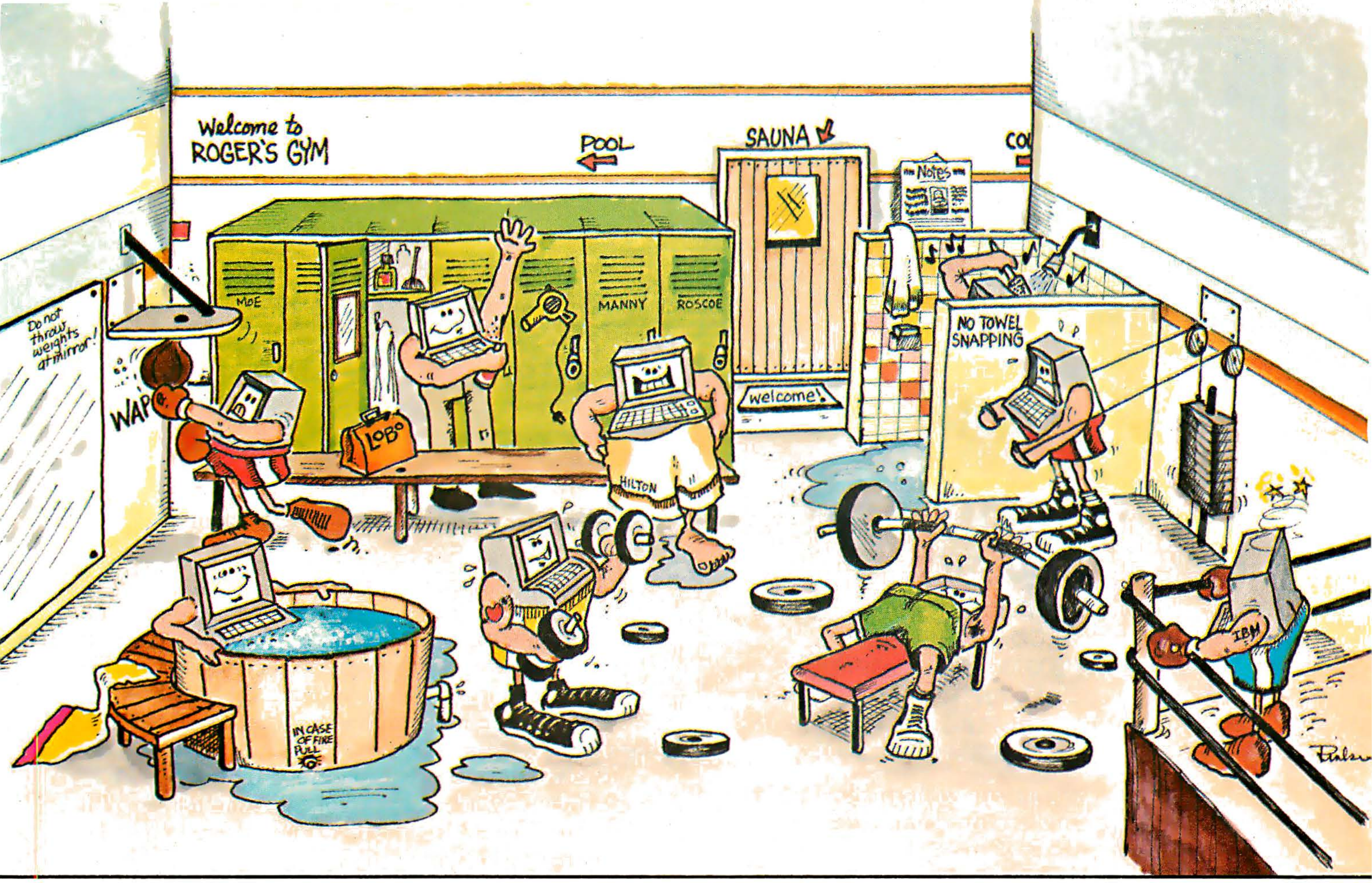
When the statement "write (remout,chout);" is encountered, the interpreter determines that a call for output to slot 2 is being made. At this time control is transferred to the BIOS location RWRITE. In order for execution to proceed satisfactorily from there, the system must recognize the card in slot 2. The situation is similar for the statement "read (remin,chin);". Thus, the program serves as a test of the BIOS modifications as well as the modem.

Summary

The library unit "micromodem" and the BIOS modifications presented here are a complete package of building blocks for developing remote communications programs using the Micromodem running under the Apple implementation of UCSD Pascal. Techniques similar to those described here should enable operators of other systems to enjoy the same advantages. ■

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1. Grogono, P. *Programming in Pascal.* Addison-Wesley, 1978.
2. Hyde, D J. *Micromodem II Owner's Manual,* 2nd edition. Norcross GA: Hayes Microcomputer Products Inc, May 1979.
3. "The Preliminary Apple Pascal Guide to Interfacing Foreign Hardware." Cupertino CA: Apple Computer Co, Dec 1979.
4. *UCSD Pascal User's Manual.* San Diego CA: SofTech Microsystems, 1978.



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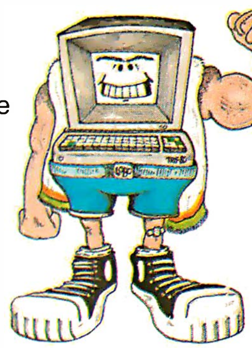
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Technical Forum

Recording with Current Instead of Voltage

David Hein
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Most of the articles I have seen on the theory of mass storage using cassettes begin with a discussion of how the magnetization of the tape depends on current flow, and how changing the head-drive current creates cells of different magnetization. During a read, it is normally assumed that the sharper the transitions between current and lack of current, the higher the output and the greater the density (or speed) that can be used.

Yet after all this discussion on current, head drive is most often performed by a voltage amplifier driven to saturation. *Current devices should be driven with current rather than voltage.*

The circuit I use for this is simple. It consists of two current drivers, some control gates for writing, an RS flip-flop for reading, and an amplifier with a gain of 200, capacitively coupled to a differential sense amplifier (see figure 1 on page 140).

Four channels along with voltage amplifiers easily fit on a two-sided, 4- by 6-inch card with standard 22-pin connectors (see photo 1). That's enough circuitry for two tracks each on twin transports.

My tape deck, which has digital (narrow-gap) heads is capable of 8 K bps (bits per second) at 5 ips (inches per second). My neighbor's standard cassette deck is capable of 2400 bps at 1⅞ ips. ■

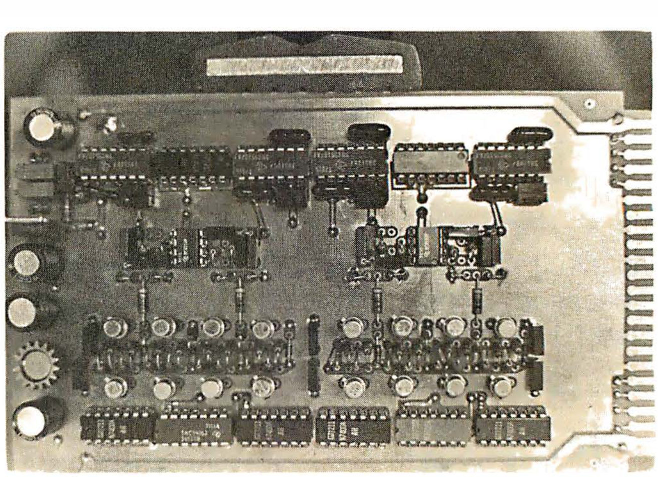
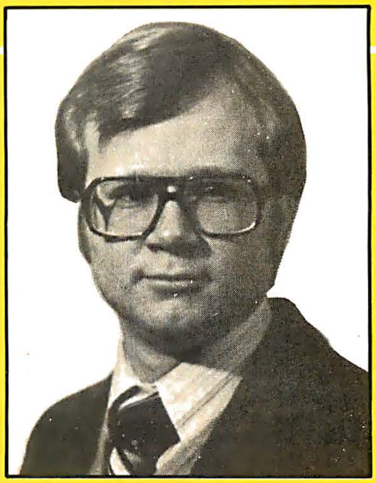


Photo 1: *Finished version of the circuit shown in figure 1. This 4- by 6-inch board with 22-pin connector has enough room for the circuitry of two tracks each on dual recorders.*

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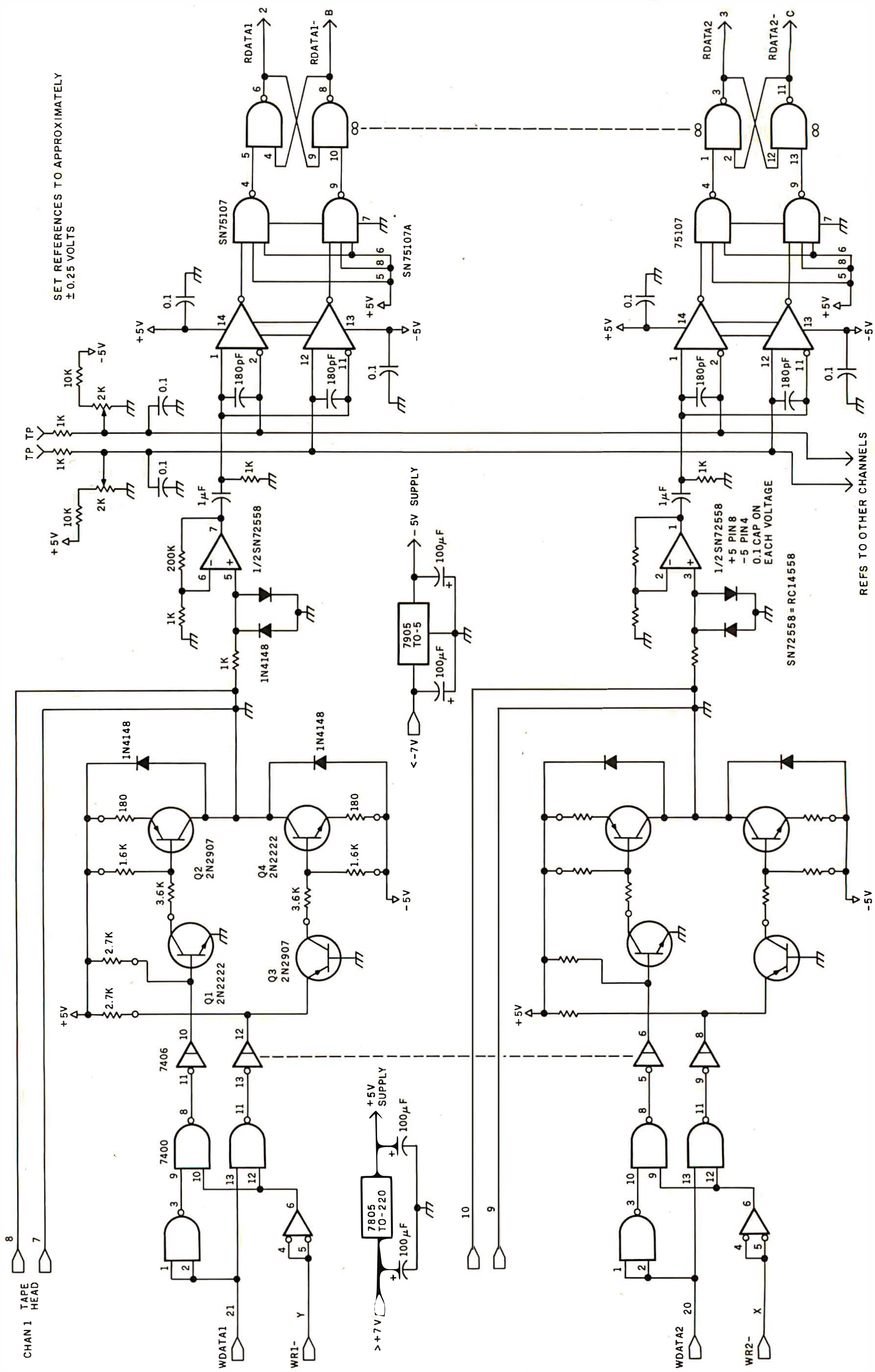
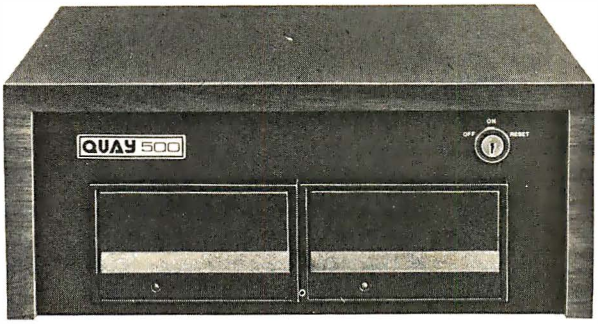


Figure 1: *A circuit for driving record heads with current rather than voltage. This simple circuit enables data transfer rates of up to 2400 bps (bits per second) on a standard cassette tape recorder.*

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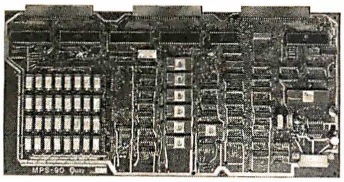
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Dynamic Memory: Making an Intelligent Decision

Larry Malakoff
Measurement Systems and Controls
867 N Main St
Orange CA 92668

Mention the words *dynamic memory* to an S-100 bus user and the responses will vary from one end of the spectrum to the other. In the early days of the S-100 bus, many users had bad experiences with poorly designed dynamic-memory boards. The problems varied from inadequate memory refreshing to designs that worked with only a particular processor board. However, things have come a long way since then. For the vast majority of today's applications, dynamic memory offers the best cost/performance ratio available. With so many of the large S-100 computer manufacturers such as Cromemco, North Star, Vector Graphic, and others using dynamic memory in their systems, all users should seriously consider the advantages of including dynamic memory in their next system design.

Dynamic vs Static

In the S-100 world, static memory is the alternative to dynamic memory. When comparing the two types, three major advantages of dynamic memory are apparent. First, dynamic boards contain more memory than static boards. Even with the supporting control logic that dynamic memory requires, today's largest available S-100 memory-board sizes are 64 K bytes for dynamic memory and 32 K bytes for static memory. For those systems that require large amounts of memory, such as the Cromemco and Alpha Micro multi-user systems, the increased density of dynamic memory can mean the difference between having enough available slots on the motherboard for all the cards necessary to complete the system or not being able to fit all of the required cards into a given chassis.

The second and probably most important advantage of dynamic memory is the low level of power dissipated. This not only reduces the amount of heat generated, but also reduces the current requirements from the power supply. A typical 64 K-byte dynamic-memory board dissipates approximately 8 watts of total power compared to as much as 50 watts for 64 K bytes of static memory. This decrease in power dissipation of more than sixfold can make a big difference in the reliability of the entire system. This is especially true when the system contains more than 64 K bytes of memory, as in a multi-user application. Since the reliability factor for electronic equipment decreases exponentially as the operating temperature increases, the mean time between failures can be drastically improved by using dynamic memories in the larger memory-intensive systems.

The third major advantage of dynamic memory is cost. Historically, its cost has always been lower, and this will continue to be so due to the increased density of dynamic-memory circuits. Once an integrated-circuit manufacturer has regained the initial development investment (assuming the yields are about equal), the price for higher-density dynamic-memory circuits can be about the same as for lower-density static-memory devices. Since it takes sixty-four of the 4 K-by-1-bit static-memory devices to build a 32 K-byte memory board as compared to thirty-two of the 16 K-by-1-bit dynamic-memory circuits to build a 64 K-byte dynamic-memory board, it becomes apparent, even when the control logic is taken into account, that a dynamic-memory board costs less to build than the corresponding static-memory board.

In comparing the two types of memory, there is one application where static memory may be a better choice. Not all types of DMA (direct memory access) controllers will correctly interface with all types of dynamic-memory boards. Depending on the particular DMA controller, static memory may be the only type that will work correctly. More will be said about this later.

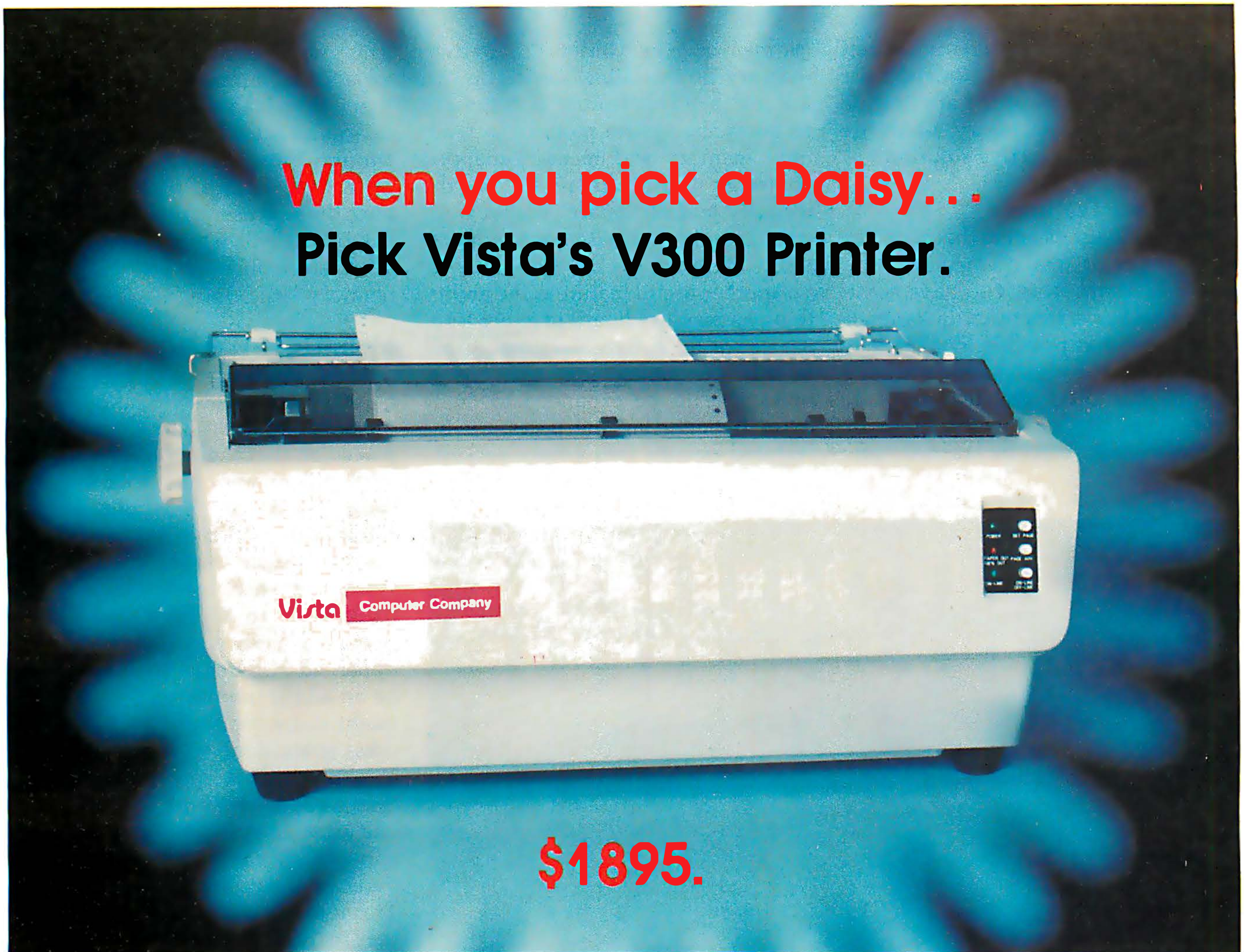
Memory Features to Look For

Now that the general merits of dynamic-memory boards have been brought to light, it is important to discuss some of the differences between the commercially available designs, and what features in particular to look for when choosing a dynamic-memory board for your system. This discussion will be separated into two application areas —those requiring a maximum of 64 K bytes of memory and those requiring more than 64 K bytes of memory (for multi-user and multitasking applications incorporating software-controlled, bank-selectable memory).

Many manufacturers make only one memory-board product that tries to bridge the gap between the two types of applications. However, these two applications require that the

About the Author

Larry Malakoff is the Marketing Director of Measurement Systems and Controls Inc, located in Orange, California. He has been involved in the design of S-100 dynamic-memory boards and is currently working with customers to solve their application requirements for system memory. Larry received his Master of Science in Engineering from UCLA and has been involved in electronic design for over eight years.



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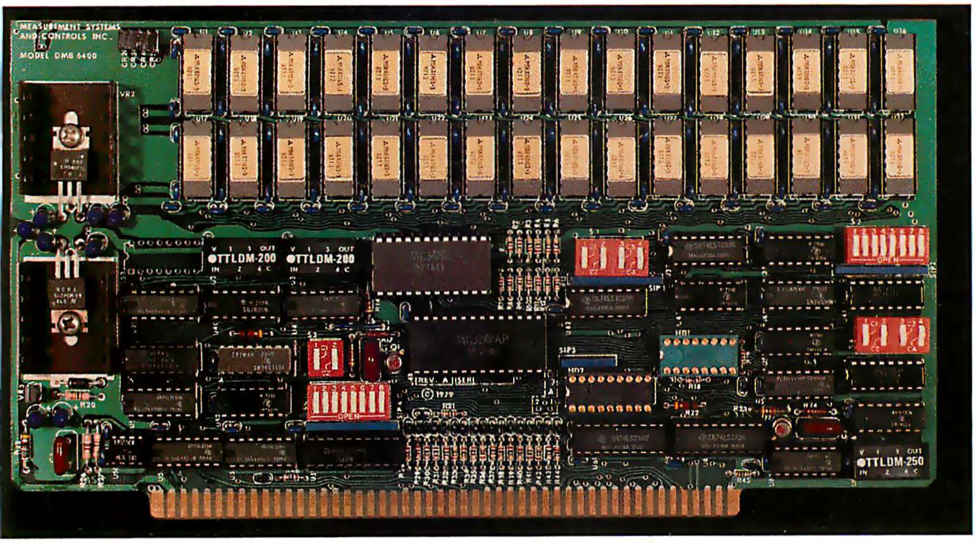
memory used have different features, often resulting in a compromise where one or both of the application areas lacks the necessary hardware for a truly cost-effective solution.

Single-User Features

In a single-user system that requires 64 K bytes or less of memory, the most important feature to have is the ability to *deselect* memory in as small an increment as possible. For the majority of 64 K-byte dynamic-memory boards that offer this feature, 4 K bytes is usually the smallest block of memory that can be turned off. (Some of the older 16 K-byte memory boards allow deselection to 1 K bytes.) This feature is necessary to allow the system monitor in read-only memory and memory-mapped controller cards to reside in the memory-address space without interfering with normal memory operations.

Another useful feature is the ability to buy a memory board in either a 16, 32, 48, or 64 K-byte size, with those boards containing less than 64 K bytes able to be expanded to 64 K bytes by inserting the necessary integrated circuits into empty sockets. This gives the small user the ability to expand as necessary. It is important that the manufacturer test these boards as full 64 K-byte boards even though they may be sold as 16 K-byte boards. This is the only way the end user can be assured that the board will work when the extra devices are plugged in to increase the memory size.

1a



1b

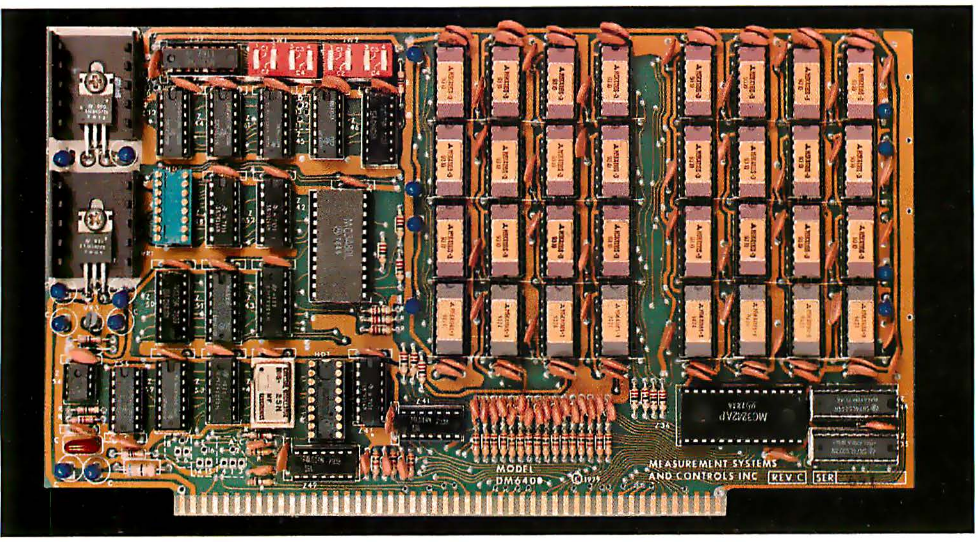


Photo 1: *Different kinds of memory boards. These two 64 K-byte memory boards have fundamental differences that tailor them for specific types of systems. The Measurement Systems and Controls DMB6400 (photo 1a) is intended for multi-user and multitasking systems and provides a bank-select feature so that memory addresses may be shared by users. The DM6400 (photo 1b) is produced specifically for single-user systems and has a deselect feature that allows memory-mapped peripherals to occupy any 4 K address block. Both boards are manufactured by Measurement Systems and Controls of Orange, California. Prices are $1195 and $895 respectively.*

Multi-User Features

Most multi-user and multitasking S-100 systems require bank-selectable memory boards. The requirements placed on the memory board for these applications are quite different from those placed on the single-user applications. A typical multi-user system might have an operating system of 48 K bytes and five user banks of 16 K bytes each. The operating system might occupy the upper 48 K-byte address space and be on all the time, while the five users might share the lower 16 K-byte address space. Only one user can be on at a time (there can never be more than 64 K bytes of memory on at any one time), but the operating system allows all five users to access the computer on a rotating timeshared basis. Through software control, each of the 16 K-byte banks of memory is turned on or off as required. This is usually accomplished by doing an OUT instruction to a particular I/O (input/output) port that the memory board is set to decode. The data on the bus then determines which banks are to be on or off.

A 64 K-byte dynamic-memory board optimized for this type of application would allow the user to implement the above example with only two memory boards. Other 64 K-byte dynamic-memory boards that compromise on the hardware design would require one 48 K-byte memory board and five 16 K-byte memory boards. In this case, the number of motherboard slots required increases, the total power dissipation increases, and the total cost of memory increases.

The difference between the two memory boards in the above example is in how the 64 K bytes of memory are partitioned into software-selectable banks. The optimal design, considering the limitations of board "real estate," is to have four totally independent 16 K-byte banks of memory. This allows the user to have

bank sizes that are any multiple of 16 K, such as four 16 K-byte banks or two 32 K-byte banks or one 16 K-byte bank and one 48 K-byte bank, etc, all of which are software selectable. In addition, the four banks should be independently addressable on the four 16 K boundaries: hexadecimal 0000, 4000, 8000, and C000. A much more simplistic approach is to bank-select the entire memory board, the bank size then being determined by the size of the memory on the board.

Other important features that a bank-selectable memory board should have include the ability to decode any of the possible 256 I/O port addresses and have up to eight banks of memory for each port address. In addition, the user should be able to turn on or off any of the switchable banks when a system reset occurs. One last feature, which can be very valuable when troubleshooting a system with more than one 64 K-byte bank-selectable memory board, is an LED (light-emitting diode) indicator for each bank of memory that is being accessed. The flashing pattern of the LEDs can indicate where a problem is.

One last word on bank-selectable memory is that a well-designed board will allow the user to work correctly with the slightly different approaches taken by the main manufacturers of multi-user systems: Alpha Micro, Cromemco, North Star, and Digital Research. (Digital Research only supplies the multi-user operating system, MP/M.)

Common Features

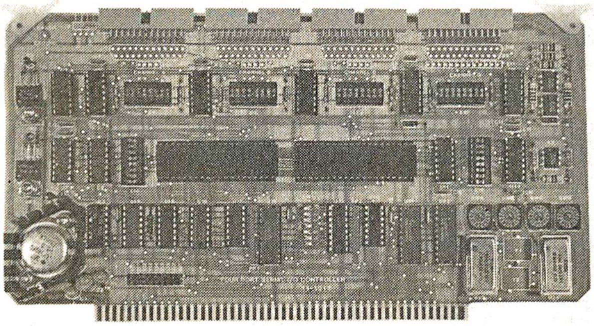
There are several other important features that are common to both single-user- and multi-user-optimized memory boards that the system designer should look for. The most important feature is the ability of the memory board to work with as many different processor boards as possible. This includes the standard 8080A-, Z80A-, and 8085-based boards, as well as the more advanced 16-bit machines (such as Alpha Micro and Marinchip's M9900).

This would not seem to be a major problem since all products manufactured for the S-100 bus should work with one another. However, in the real world this is not always the case. The S-100 bus started with and was defined around the 8080 microprocessor. As other microprocessors made their way onto the S-100 bus, they had to emulate the timing of the 8080. Each company came up with its own version for this timing. As a result, it is difficult to find two Z80A boards that generate their S-100 signals alike.

This creates a challenge to the dynamic-memory board manufacturers to come up with a flexible internal-timing scheme that allows the memory-timing circuits to adjust to the differences in the processor boards. The best way to achieve this is to use a minimum number of the S-100 bus-timing signals and, if at all possible, to avoid the use of the pSYNC signal. This one signal has created more problems than any other due to the many different processor-board designs manufacturers have come up with. The best designed dynamic-memory boards will correctly interface with the vast majority of the different board types available today, but no single dynamic-memory board can claim to work with them all.

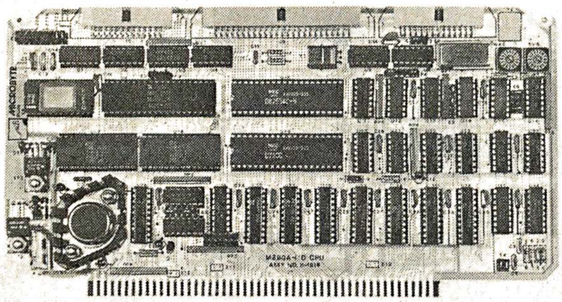
Most of today's dynamic-memory boards use transparent (or invisible) refresh. A window in the processor timing is found where the memory

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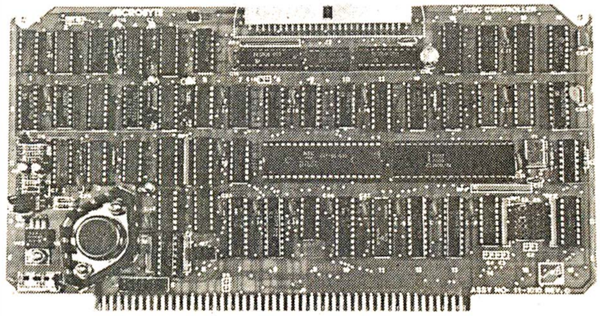
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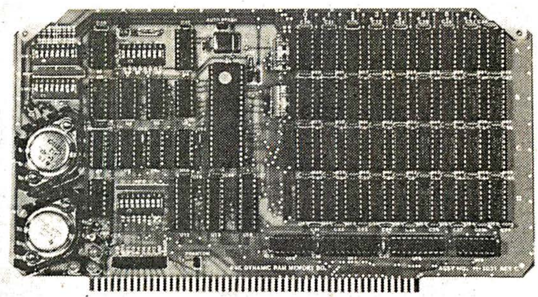
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read and write operations are not being executed, thus allowing a refresh operation to take place without requiring the processor to wait. The result is that the system is not slowed down by the necessary refresh cycles.

A different type of refresh must be done whenever the $\overline{\text{RESET}}$ or pWAIT (S-100 bus) signals are active for any extended period of time (more than several tens of microseconds). These conditions occur whenever the system-reset switch is activated or whenever a disk access to certain disk controllers is being performed using a programmed I/O interface. Either of these conditions stops the processor-generated timing that is required by the memory board for transparent refresh. Thus, the occurrence of either of these conditions must cause the memory board to enter an automatic refresh mode that continues until the processor again starts its generation of the timing signals.

Another feature that most memory boards incorporate is the use of the $\overline{\text{PHANTOM}}$ signal from the S-100 bus. This allows read-only memory on the disk controller or other board to overlay the system programmable memory to load an initial program from disk.

Other features to look for include input filters on the address and control lines followed by Schmitt-triggered input gates. This minimizes the false starting of memory cycles due to noise on the bus signals. Good logic design also dictates the use of clocked-logic or precision-delay lines for the generation of internal-memory timing, but under no circumstances should RC (resistor/capacitor network) circuits be used between logic gates to generate delays. Products using this technique are unstable under many operating and manufacturing conditions and can only cause eventual trouble.

One other important requirement

of dynamic-memory boards is good documentation. This should include board set-up documentation, detailed theory of operation, schematics, timing diagrams for the different processor-board types, a parts list, a board-layout drawing, and applications notes.

Finally, the dynamic-memory board should be backed up by the manufacturer through both guarantee and applications support. Several of the available memory boards come with a full one-year guarantee. The manufacturer should also be able to support the product with the necessary applications information to determine if it will work in your particular system.

Limitations of Dynamic Memories

Although dynamic memory usually represents the best cost/performance ratio, there are several limitations that may prevent it from functioning correctly. The system designer should investigate these cases with the memory-board manufacturer before deciding to use a product.

It should be apparent from the above discussion that not all dynamic-memory boards will work with all processor boards. Only the manufacturer can tell you if the memory board has been tested with the particular processor board you are planning to use.

Another troublesome area is in interfacing with DMA controllers. Generally, the problems arise from two different sources. First, the actual timing required from the DMA controller will vary depending on the particular memory board used. Not all memory boards use the same S-100 bus signals, thus complicating the DMA interface. If this timing is not compatible, then the memory read or write cycles will not function correctly.

The second trouble area involves the correct refreshing of the memory. The majority of the dynamic-memory devices used today are the 4116-type, which require 128 refresh cycles every two milliseconds. This requirement is easily met when the processor controls the bus and the memory board uses transparent refresh. However, when the DMA controller takes over the bus, most memory boards will cease to do refresh cycles. If the DMA controller has access to the bus for a small number of byte transfers, this does not present a problem.

A problem may exist, however, when the DMA controller does a burst sector or track transfer. This may prevent refresh from occurring for too long a time interval, causing the memory to lose data. Some DMA controllers, particularly hard-disk controllers, avoid this problem by doing the DMA transfer to an on-board sector buffer consisting of static memory. Memory or I/O move instructions are then used to transfer the data in this memory to the system memory. Again, it is important to check with the memory-board manufacturer for compatibility with the DMA controller you plan on using.

One last area of concern involves interfacing with a front-panel type of system. Extra circuitry is required for a dynamic-memory board to correctly work with the front-panel functions such as *examine*, *deposit*, and *run*. Many memory-board manufacturers do not include this necessary circuitry so that they may add other functions that they think are more valuable in their intended marketplace. If you need this function, check with the memory-board manufacturer.

In summary, the dynamic-memory board represents a superior cost/performance ratio when compared to static memories. When looking at dynamic-memory boards, choose one that is optimized for your particular application, whether it be a single-user or multi-user system. It is also a good policy to check with the memory-board manufacturer before your purchase to verify that the board will work correctly in your particular system. You are best protected by a good return policy in case you experience any problems after testing the memory board. ■

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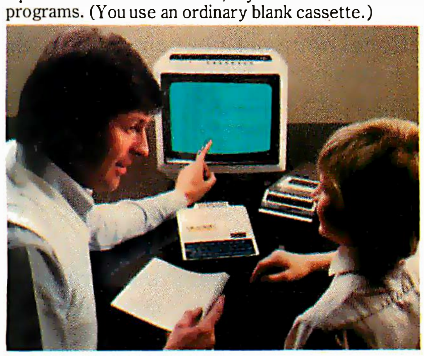
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BY-2-1

Stacking Strings in FORTH

John J Cassady
339 15th St
Oakland CA 94612

Anyone who is familiar with writing programs in BASIC and who later switches to writing in FORTH surely misses the convenience and ease of BASIC string handling. Fortunately, there is no need to deprive yourself all these features: they can be implemented in FORTH with the additional bonus of not being tied to the preconceived ideas of your software vendor. If you do not like the way the string operators work, you can change them: you control the source code.

Adding Strings to FORTH

Tools for manipulating strings of characters and other data items are useful to the personal computer programmer. The routines presented here are an extension to FORTH. They run in fig-FORTH (the versions of FORTH for various microprocessors written by the FORTH Interest Group) and should run with little adaptation in any standard FORTH.

String implementations abound in FORTH. Some, like the one presented here, use stacks. The use of stacks seems appropriate in FORTH. Most of FORTH programming consists of manipulating entities on various stacks.

A stack is a LIFO (last in, first out) list. Stacks usually have a fixed width; that is, the number of bits that are simultaneously *pushed* (ie: put onto the stack) or *popped* (ie: taken off the stack) does not vary. An item on the stack is usually limited to some maximum size (eg: 16 bits) that can represent numbers up to decimal 65,535. The FORTH parameter and return stacks both have fixed widths.

The string stack is like the parameter stack and the return stack, but it is not restricted in width. String-stack items can be any width and any combination of widths. However, item size and total stack size are limited only by the amount of memory devoted to them. As a rule of thumb, a few hundred bytes are more than enough.

Figures 1 and 2 and listing 1 illustrate two ways of visualizing string stacks. They show the stacks growing downward from high memory. This is typical in FORTH. Even though the string stack grows downward, we will refer to the most recent entry on the stack as the *top* of the stack. The unchanging *end* of the stack (hexadecimal 2000 in figure 2) will be called the *base*. When something is popped

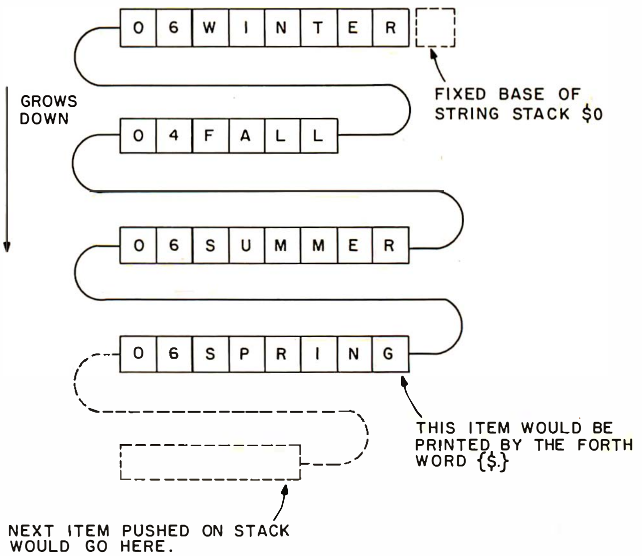


Figure 1: *One implementation of a string stack in FORTH. As the name implies, a string stack is a stack of variable-length strings (as opposed to fixed-length numbers) organized such that only the string most recently put on top of the stack can be removed from the stack. Each stack entry consists of the length of the string, expressed in 2 bytes, followed by the characters of the string itself. Due to an initial design decision, this string grows toward low memory locations (ie: down) rather than toward high memory locations (ie: up). Despite this physical orientation, the most recently placed string is located at the top of the stack — at the lowest address in the stack.*

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from the stack, it is the top item (as defined above) that is removed.

A string consists of a 2-byte length word followed by the text of the string, as you are moving upward in memory. Since the length is explicitly stated, there is no need for a separator or delimiter. Any of the 256 possible 8-bit quantities, for example, can appear in the string. Strings can include binary numbers, floating-point numbers, encrypted messages: in short, anything that can be stored in a byte.

Before considering routines any further, heed the caution that this article presents an example of an extension to FORTH. It's not the only way to implement strings nor, perhaps, the best way. The article

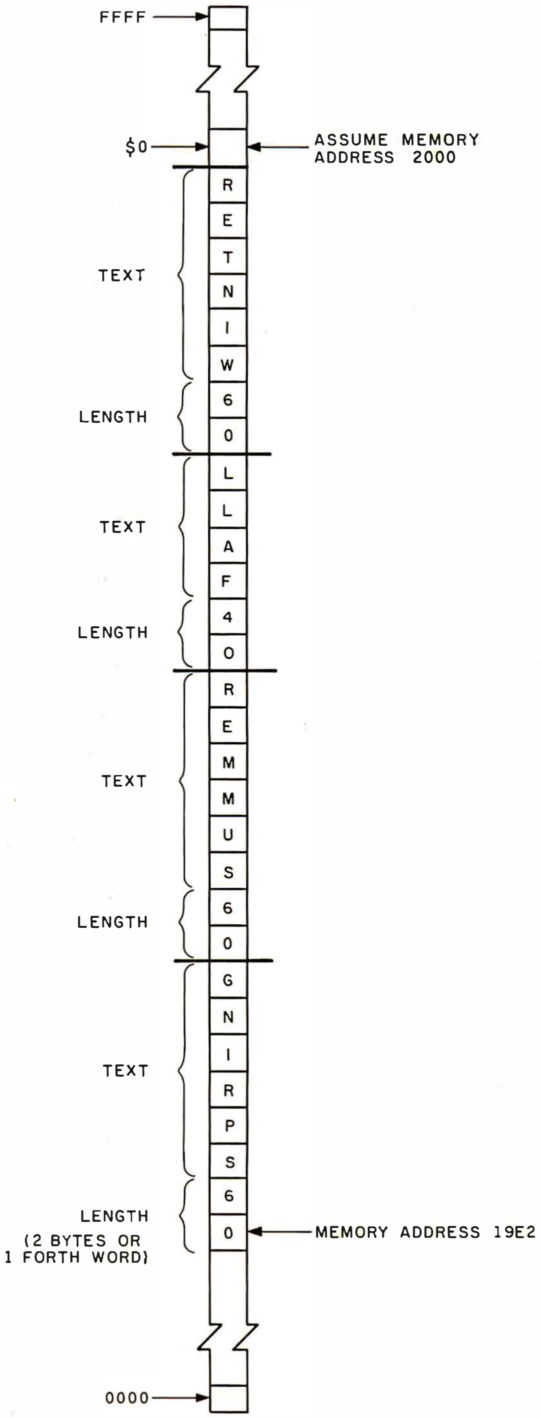
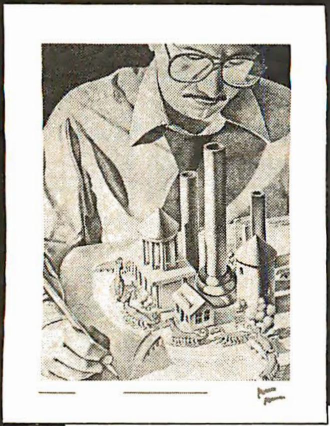


Figure 2: *Another view of the string stack of figure 1. $0 is a constant that points to the address of the base of the string stack. Here it has the value of hexadecimal 2000. See listing 1 for the FORTH dialogue that uses the string stack shown here.*

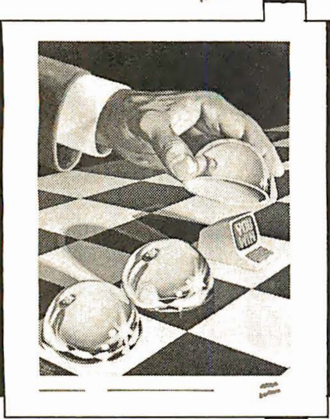
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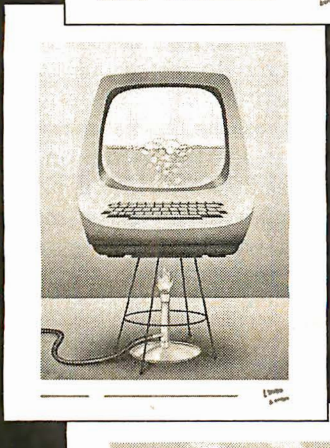
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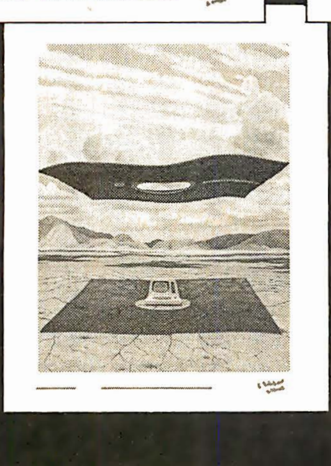
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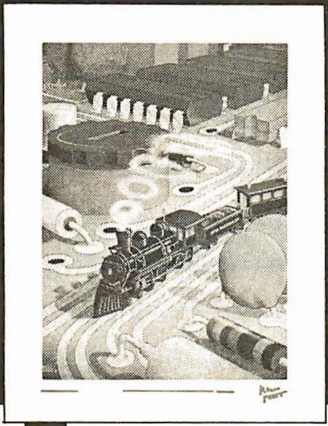
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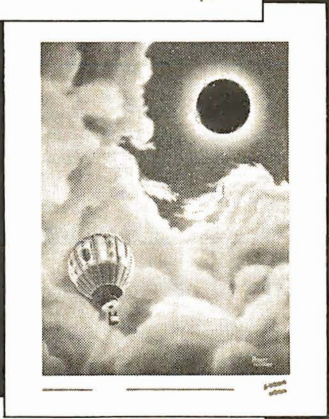
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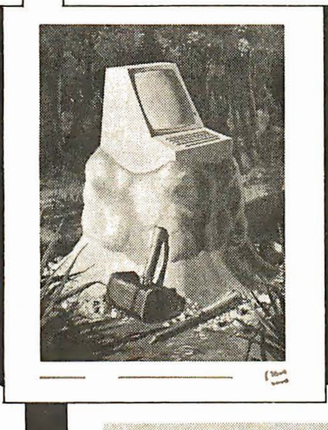
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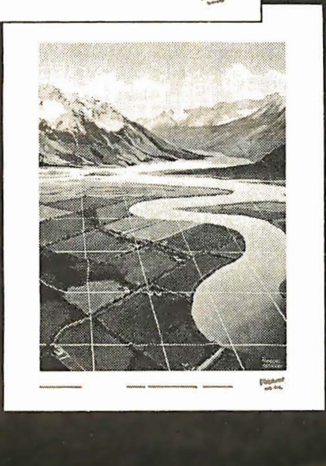
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simply illustrates a FORTH program and an interesting mixture of two quite distinct logical structures: the stack and the string. And it has some desirable features: it is easy to visualize and modify the operations.

Some String-Manipulation Words

In listing 2, the word *$* creates a constant with a value equal to the size of memory to be reserved for the string stack during compilation. The stack size can be changed simply by changing this one value and recompiling.

The words $0 , $P , and { $P! } are direct duplicates of the words S0 , SP , and { SP! } used in the FORTH kernel. The only difference is that they operate on the string stack instead of on the parameter stack. $0 is a constant that returns the address of the fixed end of the string stack (ie: the base) to the parameter stack. (See line 4 of listing 2.) This means that the value of $0 , the memory address, is pushed onto the parameter stack when it is used.

$P is a variable. It is the stack pointer. At any given time, it contains the address of the top string on the stack (which is the length word of the top string). When $P is executed, it places the *address* (not the value) of the stack pointer onto the parameter stack. Therefore, to get the *value* of the string-stack pointer, we need to type the following two-word sequence:

$P @

This sequence is reduced to a single word $P@ , which is defined at line 7 of listing 2. Listing 3 shows a FORTH dialogue that explains the use of VARIABLE , CONSTANT , and @ (pronounced "fetch").

The word { $P! } empties the string stack. [*The braces used in* { $P! } *and elsewhere in the article are* not *part of the FORTH word. Following a convention set in the August 1980 BYTE, braces are used to surround a FORTH phrase or a FORTH word that contains a punctuation mark....***GW**] It does this by placing the value for the base of the string stack onto the parameter stack and making it the current value for the string-stack pointer. The word { $P! } is the first colon definition encountered. The words CONSTANT , VARIABLE , and { : } compile words into the FORTH dictionary.

Our next definition, in line 8 of listing 2, is $DROP . This will drop (ie: delete) the string on top of the string stack. It may seem we are getting ahead of ourselves — after all, we are defining $DROP before we define any word that puts strings onto the string stack. But this is okay as long as we don't use any undefined words inside the definition. FORTH compiles its words in one pass, and it won't give us an error message as long as we don't give it a word it doesn't recognize.

If we "walk" through $DROP , we see that the value of the string-stack pointer is placed on the parameter stack by the word $P@ . It is then duplicated by the word DUP , leaving two copies. The top copy of the address is replaced by the contents of the location pointed to when the word @ is executed. This places the length of the top string on the parameter stack. The word + adds this length to the value of the stack pointer, and 2+ increments that result by 2. The value on top of the parameter stack is now the address of the word containing the length of the second string on the string stack.

The sequence { $P ! } is a two-step process that places the address of the variable containing the string-stack pointer on the parameter stack and storing the new value into it. Thus, after executing $DROP , the string-stack pointer is changed to point to what was the next-to-top string. This effectively drops the top string, even though there was nothing changed in the contents of the memory buffer devoted to the string stack.

This definition of $DROP is not entirely adequate. If you execute this word with an empty string stack, there is a good chance of moving your string-stack pointer into a memory area where it doesn't belong. To avoid this, additional code must be added. The word $DROP should check that the stack is not empty before it executes. Safeguards of this nature are appropriate in many of these routines. To include them in this article would, however, needlessly complicate the description of the words.

Loading, Storing, and Printing Strings

The word $@ (line 9 of listing 2) is the first that expects parameters on the parameter stack. It expects a text address as the second stack item and a quantity on top of the stack. The text address points to a memory location of the first byte of the string that will be moved to the string stack. The quantity is the length of the string. Thus, if the expression "the quick brown fox" was residing in memory starting at hexadecimal location 2C80 and we wanted to move it to the string stack, we would type the following sequence:

```
2C80 13 $@
```

with the hexadecimal 13 (or decimal 19) being the length of the string. The quantities could be in decimal if the FORTH word BASE has been set to decimal.

The word { $! } complements $@ . It takes the string on top of the string stack and moves its text to whatever memory location is addressed by the top of the parameter stack. Thus, the string can be moved into a string variable, to an output buffer, or to a memory-mapped video display.

To print a string we use the two-character word { $. } (pronounced "string dot"). This follows the FORTH convention of using dot for output. It also uses the FORTH operator TYPE to accomplish it.

$DUP (line 13 of listing 2) is shown as an example of one of several operators that might be written to manipulate string-stack items. Useful additions are $SWAP and $OVER. The need could also arise for a $ROT , although I've never wanted it. $DUP simply gets the length and location of the current top string on the string stack and executes $@ .

For a truly useful system, we want a person to sit at a keyboard and be able to type a sentence directly to the string stack. This and more is accomplished by the one-character FORTH word { " } (pronounced "quote"). The techniques used in quote are exactly the same as in the fig-FORTH message-handler word { ." }. This word (pronounced "dot quote") is a period followed by a double quote mark. This word checks to see if we are interpreting from the keyboard or compiling a definition. If we are interpreting, it accepts input until it detects another quote, then moves the text between the two quotes to the string stack. If we are compiling a

Text continued on page 162

Listing 1: *Manipulating the string stack and string pointer. Figures 1 and 2 show the state of the string stack at the beginning of this dialogue. Here and in following listings, user input is underlined and computer response is not. See listing 3 for further details on the FORTH word @ (pronounced "fetch").*

Dialogue With Computer	Commentary
HEX OK	All numbers will be expressed as hexadecimal.
$0 . 2000 OK	Base of string stack is hexadecimal 2000.
$P @ . 19E2 OK	Location pointed to by stack pointer $P.
$P @ @ . 6 OK	Contents of location (length word of string on top of stack).
$. SPRINGOK	Print top string; notice no space between STRING and prompt OK.
$0 . 2000 OK	The base of the stack hasn't changed. (It's a constant.)
$P @ . 19EA OK $P @ @ . 6 OK	But the stack pointer has changed.
$. SUMMEROK $. FALLOK $. WINTEROK	Print the next three strings, popping them from the string stack.

Listing 2: *Defining string-manipulating words. See text for details.*

```
( FORTH STRING STACK EXTENSION                        FIGFORTH1.1  )
HEX  FORTH DEFINITIONS
200 CONSTANT  *$*            (NUMBER OF BYTES RESERVED FOR $STK    )
*$*  ALLOT  (  LEAVE  GAP  IN THE DICTIONARY OF *$* BYTES FOR $STK )
HERE  CONSTANT  $0        (  $0 RETURNS FIXED BASE OF $STK TO PSTK )
$0  VARIABLE  $P        (  $P RETURNS ADDR OF VAR HOLDING $STK PTR )
:  $P!   $0   $P   !   ;      (  $P! EMPTIES $STK BY RESETTING $P TO $0 )
:  $P@    $P    @    ;        (  $P@ RETURNS VALUE OF $P TO PSTK   )
:  $DROP  $P@  DUP  @  +  2+  $P  !  ;         (  DROP TOP STRING  )
:  $@  DUP  >R  $P@     (  TA-2 QTY-1 - - -  FETCH STRING TO $STK  )
     SWAP  -  SWAP  OVER  R  CMOVE  2  -  R>  OVER  !  $P  !  ;
:  $! DUP 2+ SWAP @ ROT SWAP CMOVE $DROP ;  (  ADDR-1- - -         )
:  $.  $P@  DUP  2+  SWAP  @  TYPE  $DROP  ;  (  OUTPUT STRING     )
:  $DUP  $P@  DUP  2+  SWAP  @  $@  ;  (  DUPLICATE  STRING        )
;S
```

Listing 3: *A dialogue that explains the FORTH words CONSTANT , VARIABLE , @ , and { . }. The main point to remember is that when you name a constant, its value is put on the stack; but when you name a variable, the address that contains the value is put on the stack.*

Dialogue With Computer	Commentary
100 CONSTANT CON OK	Defining CON = 100.
100 VARIABLE VAR OK	Defining VAR = 100.
CON OK . 100 OK	Put **value** of constant onto stack; print value on top of stack, remove from stack; therefore, 100 is value of CON.
VAR OK . 6480 OK	Put **address** of variable onto stack; print value on top of stack, remove from stack; therefore 6480 is the memory location at which the **value** of VAR is stored.

Listing 3 continued on page 160


THE PASCAL HANDBOOK
JACQUES TIBERGHIEN
INTRODUCTION TO PASCAL
UCSD PASCAL
RODNAY ZAKS
INSIDE BASIC GAMES
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Listing 3 continued:

VAR OK @ OK	The address of VAR is on the stack. @ replaces the **address** with its contents. The value of memory location 6480 should now be on top of the stack.
. 100 OK	It is; this shows that VAR stores the value 100.
VAR @ . 100 OK VAR ? 100 OK	This can be done on one line { ? } is the same as { @ . }

Listing 4: *More string-manipulating words.*

```
( FORTH STRING STACK EXTENSION                     FIGFORTH1.1  )
: (") R DUP 2+ SWAP @          ( MOVES IN-LINE STRING TO $STACK )
  DUP 2+ R> + >R $@ ;
: "                 ( IF COMPILING EMPLACE AN IN-LINE STRING TO )
                    ( BE MOVED TO STRING STACK AT EXECUTION TIME )
                    ( ELSE PUT ENCLOSED STRING ON STRING STACK   )
  22 STATE @
  IF COMPILE (") 0 C, WORD HERE C@
     -1 ALLOT DUP , ALLOT
  ELSE 0 C, WORD HERE C@ -1 ALLOT HERE !
     HERE DUP 2+ SWAP @ $@
  ENDIF ; IMMEDIATE
;S
```

Listing 5: *More string-manipulating words.*

```
( FORTH STRING STACK EXTENSION                      FIGFORTH1.1 )
0E +ORIGIN @ CONSTANT BS ( SYSTEM BACKSPACE CHARACTER = 8      )
7F CONSTANT PBS    ( BYTE USED BY POLY 88 MONITOR AS BACKSPACE  )
: $INPUT PAD DUP   ( RTNS TEXT DELIM BY CR FROM KEYBRD TO $STK  )
  BEGIN KEY DUP BS = ( IS IT A BACKSPACE? )
     IF ( BS ) >R 2DUP = R> SWAP  ( AND AT START OF BUFFER?    )
        IF DROP 0
        ELSE DROP PBS EMIT 1 - 0
        ENDIF
     ELSE ( NOT BS ) DUP 0D = ( IS IT A RETURN? )
        IF DROP 20 EMIT 1
        ELSE DUP EMIT OVER C! 1+ 0
        ENDIF
     ENDIF
  UNTIL OVER - $@ ;
;S
```

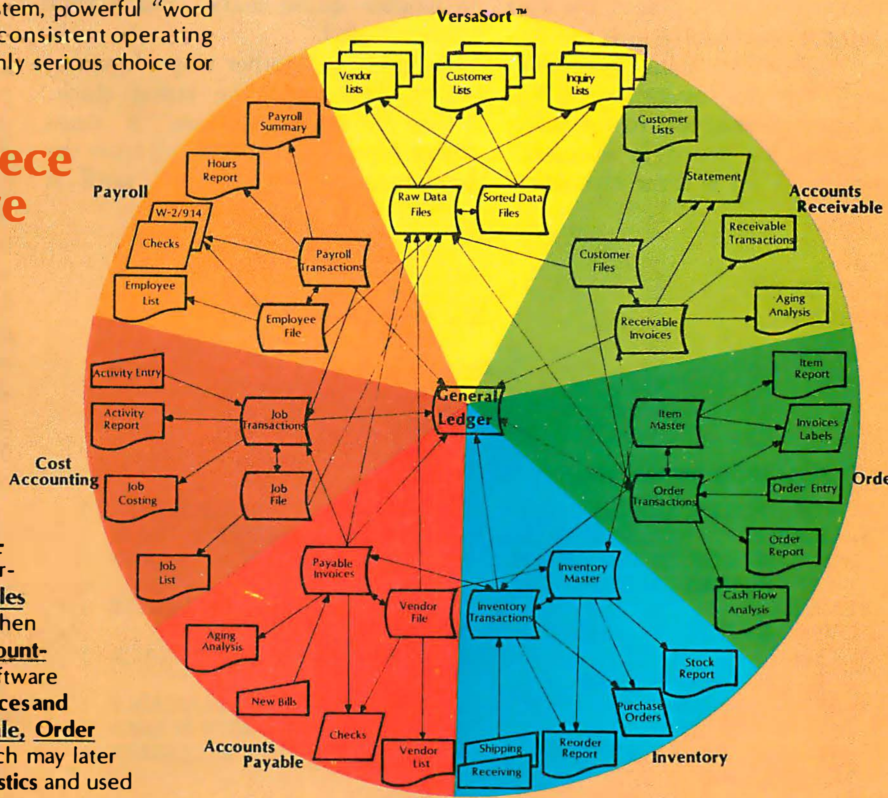
Listing 6: *Defining a word to get the date from the keyboard. This word, GETDATE, prompts for and will accept only an input of exactly seven characters.*

FORTH Statements	Commentary
7 $VARIABLE TDATE	
: GETDATE	Begin definition of word GETDATE.
BEGIN	Start BEGIN...UNTIL loop.
$P! CR	Clear string stack.
" Input today's date (DDMMMYY): " $.	Output message.
$INPUT	Accept input from keyboard.
$P@ @	Push length of string onto stack.
7 =	Compare to 7.
UNTIL	Loop to BEGIN if length of string ≠ 7.

Listing 6 continued on page 162

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Text continued from page 157:

definition, the word places the text between the two quotes into the dictionary definition being compiled, preceded by the operator { (") }, which transfers that text to the string stack when the word is executed. (The word { (") } is three characters long and consists of a left parenthesis, a double quote mark, and a right parenthesis.)

$INPUT is another way of getting string data onto the string stack. When $INPUT executes, it stops everything and waits for text from the keyboard. It accepts text until it receives a return character.

The combination of { " } and $INPUT (defined in listings 4 and 5) allows us to write programs that prompt the user to supply text to the program. For example, consider the definition given in listing 6. When GETDATE executes, it will prompt the operator with the message "Input today's date (DDMMMYY):" and wait for a response ended by a return. It will check the length of the string entered. If it is other than seven characters long, GETDATE will discard it and ask for the day's date again. If it is the correct length, the word will make the string just entered the value of the string variable TDATE.

Listing 6 continued:

```
TDATE $VAR!                         Store string in TDATE.

                                    End of definition.
```

Listing 7: *More string-manipulating words.*

```
( FORTH STRING STACK EXTENSION                          FIGFORTH1.1 )
: $VARIABLE           ( MAXLENGTH-1--- IE, 7 $VARIABLE TDATE )
   <BUILDS DUP , DUP HERE          ( USAGE: TDATE ---$A-1 )
   SWAP BLANKS ALLOT DOES> ;
: $VARFILL               ( $A-2 BYTE-1--- FILL $VAR WITH BYTE )
   OVER @ ROT 2+ SWAP ROT FILL ;
: $VAR@           ( $A-1--- FETCHES VARIABLE TO STRING STACK )
   DUP 2+ SWAP @ $@ ;
: $VAR!       ( $A-1---    POPS STRING STACK TO $VARIABLE )
   DUP BL $VARFILL                         ( PADS WITH BLANKS )
   DUP 2+ SWAP @ $P@ @ MIN ( TRUNCATE IF NECESSARY )
   $P@ 2+ ROT ROT CMOVE $DROP ;
;S
```

Listing 7 illustrates definitions that could be used to implement a system of string variables for use in a routine like the above word, GETDATE. $VARIABLE is a *defining word* that uses the special FORTH words <BUILDS and DOES>. Stated briefly, these last two words allow the user to define words (like $VARIABLE or VARIABLE) that themselves define new types of FORTH words. [*This subject was explained in greater detail in Kim Harris's article, "FORTH Extensibility," in the August 1980 BYTE, page 164....*GW]

These routines by no means provide a complete string facility. Concatenation is required, and string editing is convenient. We need to be able to extract a substring. String comparisons are essential for sorting and merging. Why not perform arithmetic directly with strings of numeric characters and avoid the tedious transformations to binary numbers and back to strings? And why not have a random string generator to check sorting efficiency or test file structures? All of these niceties can be and, in fact, have been added to the basic structure I've described.

Summary

FORTH is a "framework" language. It doesn't have every function you need, but it allows you to add new words that can be used to solve problems in a given application. Here, we have defined fifteen words that allow us to manipulate strings of characters in fig-FORTH. (See listings 2, 4, 5, 6, and 7.) This is only one of several ways to manipulate strings in FORTH. Once defined, these words can be used to manipulate text during the solution of a larger program.■

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Articulate Automata:
An Overview of Voice Synthesis

Kathryn Fons and Tim Gargagliano
1394 Rankin St
Troy MI 48084

The time has arrived for computers to begin speaking for themselves! We discussed some basic techniques for using the TRS-80 Voice Synthesizer in the October 1979 BYTE ("The TRS-80 Speaks," page 113). Response from readers showed many were interested in a more detailed look at voice synthesis. The information presented here is concerned with the basic theory of voice synthesis and the basic procedures involved in constructing a vocabulary. The type of synthesis we focus on is *electronic phoneme synthesis*. A *phoneme* is a basic unit of sound from which speech can be constructed.

Voice-Synthesis Technology

During the past two decades, almost every aspect of computer technology has progressed through several generations of advancement. A relatively recent addition to this list is speech synthesis. The area of computer technology which would seem to gain most from speech synthesis is the man-to-machine interface. This is an area which remains in need of a great deal of development. Today, computers play a role in almost everyone's life, yet we rely on a group of specialists to control the computers. If computer technology is to continue to advance, there will be a strong need for the inexperienced user to communicate directly with the computer. It seems obvious that the man-to-machine interface will be one of the biggest challenges facing this industry in the 1980s.

Another problem confronting computer users is visual confusion and/or saturation. This can occur after watching a video monitor or scanning a printout for hours at a time. Part of this problem can be eliminated by including a nonvisual output channel in the computer system. The obvious choice is voice, since most people normally communicate verbally. In a number of situations, the serial nature of voice output is more desirable than parallel data from a printout or video screen.

A number of applications are already using voice synthesis. Among these are telephone order-entry systems, telephone access systems, reading machines and terminals for the blind, communicators for the verbally impaired, and computerized dispatching.

Physiology of Speech

The production of speech in the human vocal system begins with a source of acoustical excitation to drive the vocal tract. There are two kinds of excitation: periodic and random. The first type of excitation is a pulse train caused by the vocal folds blowing apart and collapsing under lung pressure (see figure 1 on page 166). The pulse train is rich in harmonic content due to its sharp wave shape. The second type of excitation is noise (*frication*) caused by air passing over the *articulators* (tongue, cheeks, lips, teeth, etc) with the vocal folds open.

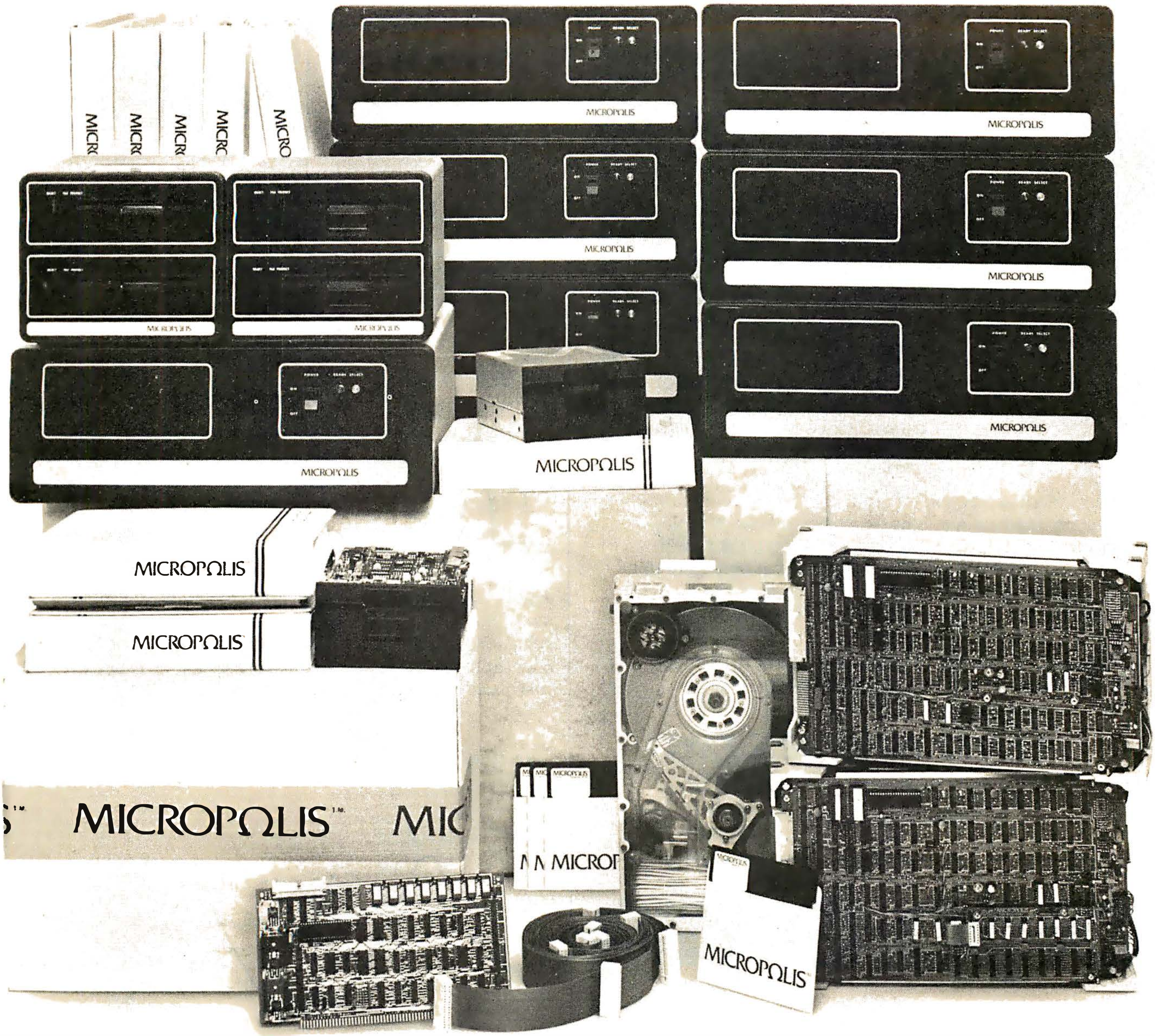
Phonemes containing periodic excitation are called *voiced phonemes* (eg: the vowel /a/). Phonemes containing only frication are said to be *unvoiced* (eg: the consonant /f/). It is also possible for a voiced phoneme to contain frication (eg: the consonant /z/).

The human vocal tract is formed from resonant cavities including the mouth and nasal cavities which respond to input excitation by filtering the input. At any given time, placement of the articulators determines the frequency response of the vocal tract. Generating speech from the input excitation involves sequentially varying the frequency response of the resonant cavities in the vocal tract. This is done by movement of the articulators. The vocal tract is a fairly complex time-variant filter network.

Speech is composed of several bands of frequencies called *formants* (see figure 2). Each formant varies in position, amplitude, and quality with respect to time. A static sound, such as a continuous vowel, is produced by moving the air through the vocal tract and over the articulators, which are appropriately positioned to create

About the Authors

The authors are both employed by the Votrax Division of Federal Screw Works in Michigan. Kathryn Fons is a speech scientist; Tim Gargagliano is a computer engineer. Both have done extensive research in language-processing systems and have worked on the Votrax text-to-speech algorithm. They have a special interest in voice synthesizers in relation to the needs of the handicapped and invite inquiries at the address shown above.



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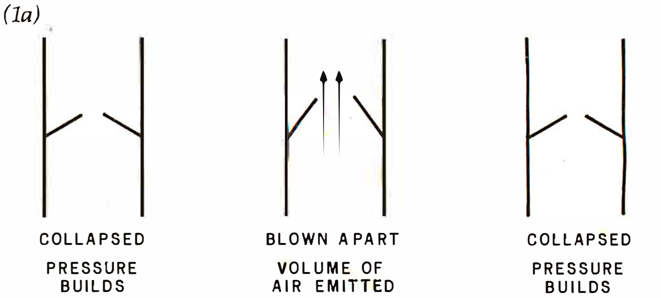
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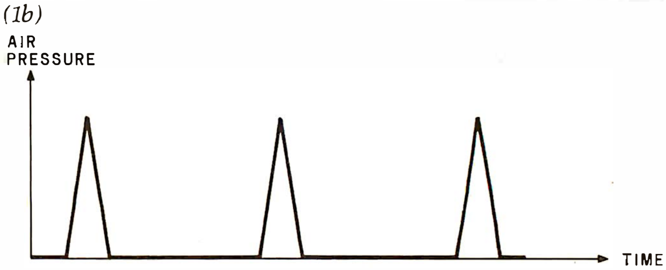


Figure 1: *Periodic excitation of the human vocal tract starts with the vocal folds repeatedly opening and closing (1a), regulating air flow from the lungs. This results in a pulse train of air (1b) which passes through the resonant cavities of the mouth and nasal passages.*

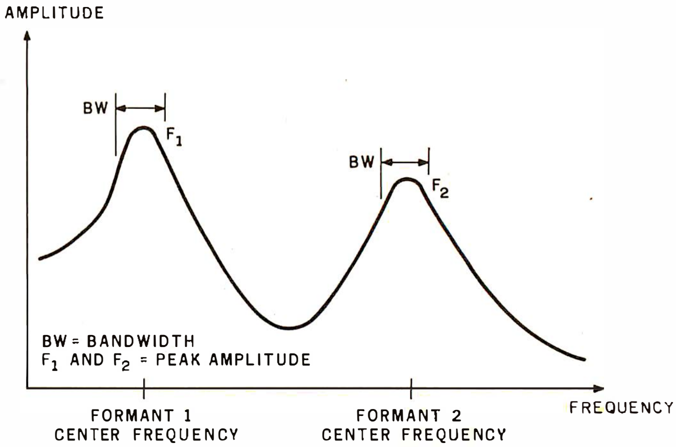


Figure 2: *Speech is composed of several bands of frequencies known as formants. Shown is a generalized formant envelope for the first two formants.*

that sound. During the production of a word, the articulators are constantly moving from one phoneme position to another. This sequencing of the articulator movements is one reason why each sound in the sequence influences every other sound around it. Note that the change in articulator positions does not occur in a single-step fashion, but rather in a continuous movement from one target position toward another. The frequency response of the vocal tract is in flux between the target of the last phoneme and the current phoneme. The acoustical changes that occur during the transition are referred to as *dynamic articulations*. They are important to the production of intelligible speech—human or synthetic. Without dynamic articulation, speech becomes choppy and often unintelligible.



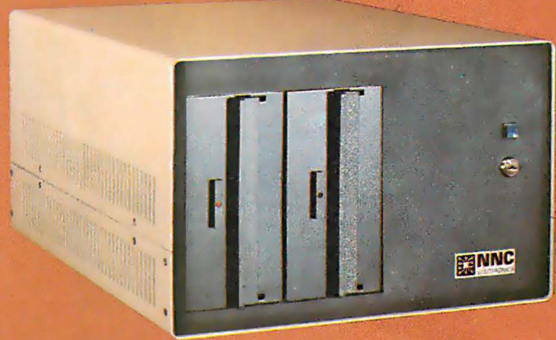
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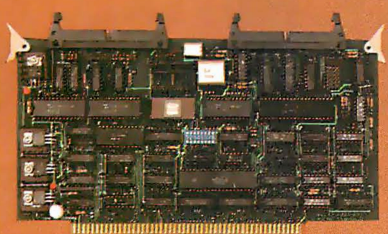
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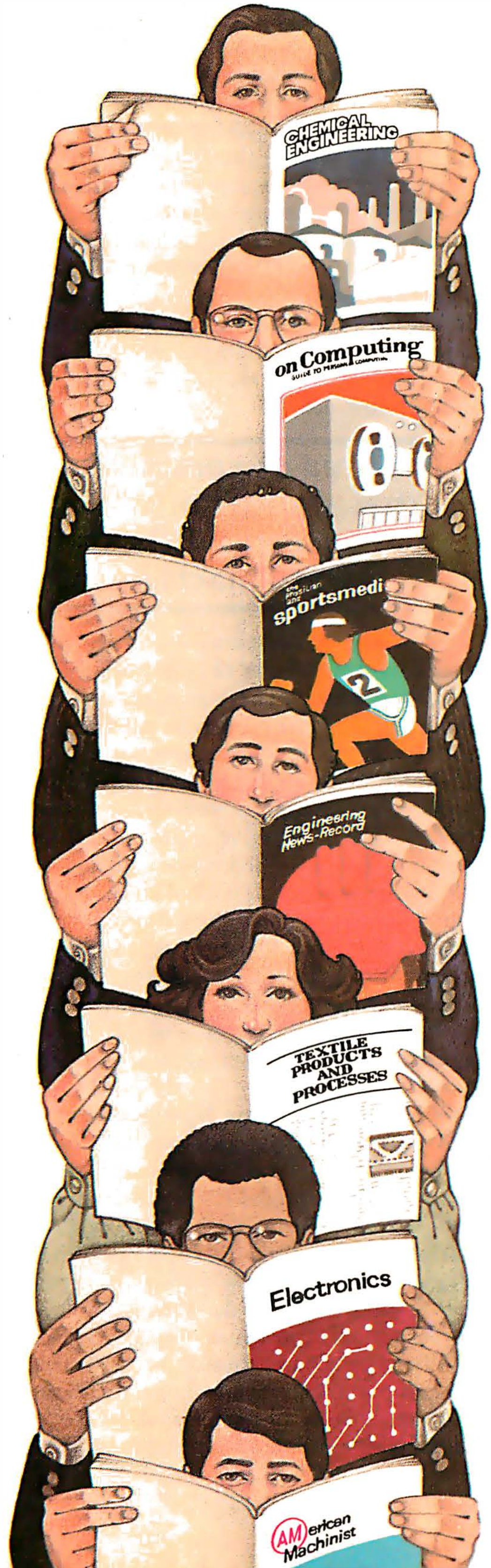
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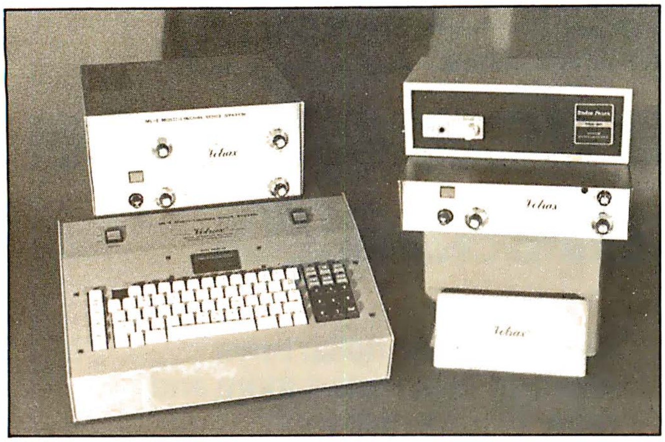


Photo 1: *A selection of voice synthesizers. Top left: Votrax ML-I multilingual synthesizer. Bottom left: phonetic keyboard for controlling a synthesizer without the use of a computer. Right top to bottom: Radio Shack TRS-80 Voice Synthesizer, Votrax VS6 synthesizer, Votrax VSK single-board voice synthesizer. Not shown: Votrax SC01 single-chip voice synthesizer.*

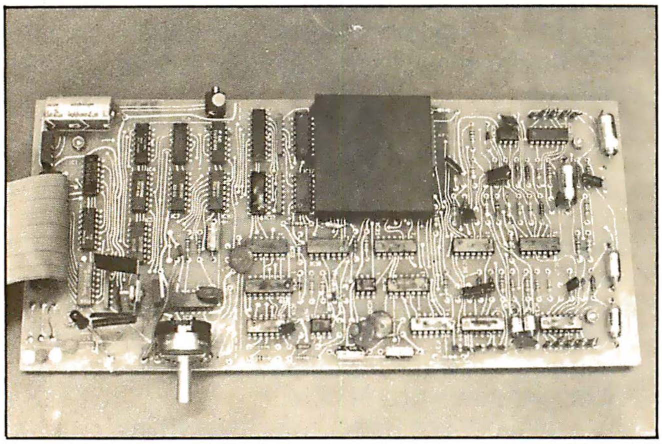


Photo 2: *An electronic analog of the human vocal tract using filters, oscillators, and noise-source modules. Control of these circuits requires an understanding of the static and dynamic parameters of human speech.*

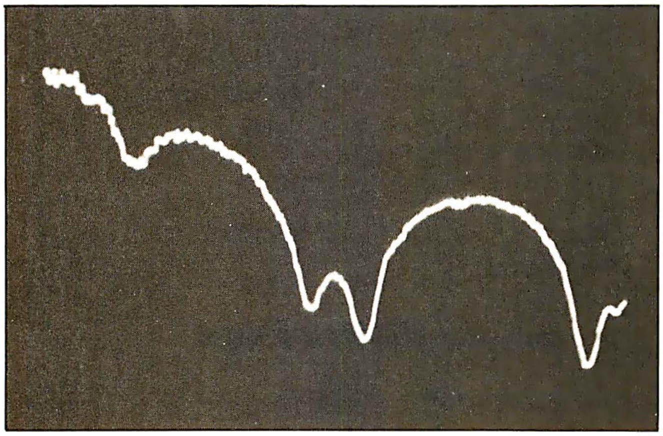


Photo 3: *A spectrum analyzer display of a static phoneme. The X axis is frequency; the Y axis is amplitude.*

The Electronic Equivalent of the Vocal Tract

An electronic analog of the human vocal tract can be constructed using filters, oscillators, and noise-source modules (see photo 2). Control of these modules is complicated, and requires measuring the static and dynamic parameters of human speech.

The study of speech parameters requires some complex instruments. Speech is most frequently considered in terms of frequency composition, rather than waveforms measured as a function of time. Therefore, analysis of speech is typically carried out in the frequency domain. This requires instruments that are able to measure and plot frequency, amplitude, and time in various relationships. A spectrum-analyzer scope can display a picture of amplitude versus frequency for an instant in time (see photo 3). This provides accurate measurement of energy distribution among the frequencies of a static sound.

Another type of spectrum analyzer used in the study of speech is a voiceprint machine. This device provides a picture of amplitude versus frequency versus time which is collapsed into two dimensions (see photo 4 on page 172). This type of printout allows us to study the dynamic characteristics of speech, such as phoneme duration and dynamic articulations. Notice how the frequencies continuously move during the transition from one phoneme to the next.

The area of computer technology that stands to gain most from speech synthesis is the man-to-machine interface.

With these instruments, measurements can be made of the center frequencies of formants, their amplitudes, and their bandwidth. These measurements are the basis for designing the filter networks used in an electronic vocal tract. A model of a voice synthesizer in its simplest form is shown in figure 3. Depending on the desired speech quality, a varying number of parameters must be controlled. The number of bits stored for each parameter depends on the needed range and quantization tolerance of each parameter. To control this type of synthesizer, parametric data must be updated every 5 to 25 ms. The update frequency must be high enough to capture the parametric movements during phoneme transitions. While this synthesizer model can provide much flexibility, it does so at the expense of a high bit-rate/storage requirement and complex vocabulary generation.

The Votrax Phoneme Synthesizer

A phoneme synthesizer can be modeled by adding a parametric control generator and a dynamic-articulation control unit. A model for a Votrax phoneme synthesizer with several options is shown in figure 4 on page 174. Rather than have the user update all the parameters of a phoneme several times during its production, the synthesizer automatically does it using an internal algorithm. Because the Votrax phoneme synthesizer is implemented totally in hardware, there is no requirement for an external computer/memory to generate phonemes.

A high-quality phoneme synthesizer (with many internal parameters) is no more complex for the user to con-

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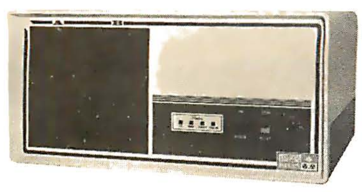
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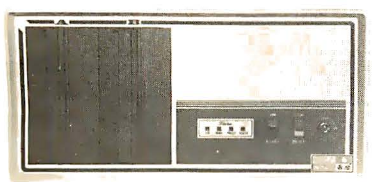
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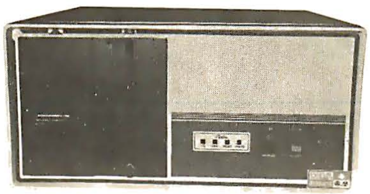
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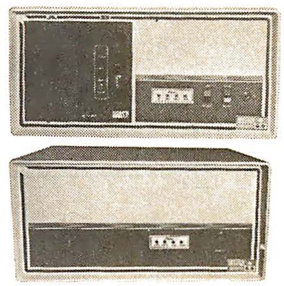
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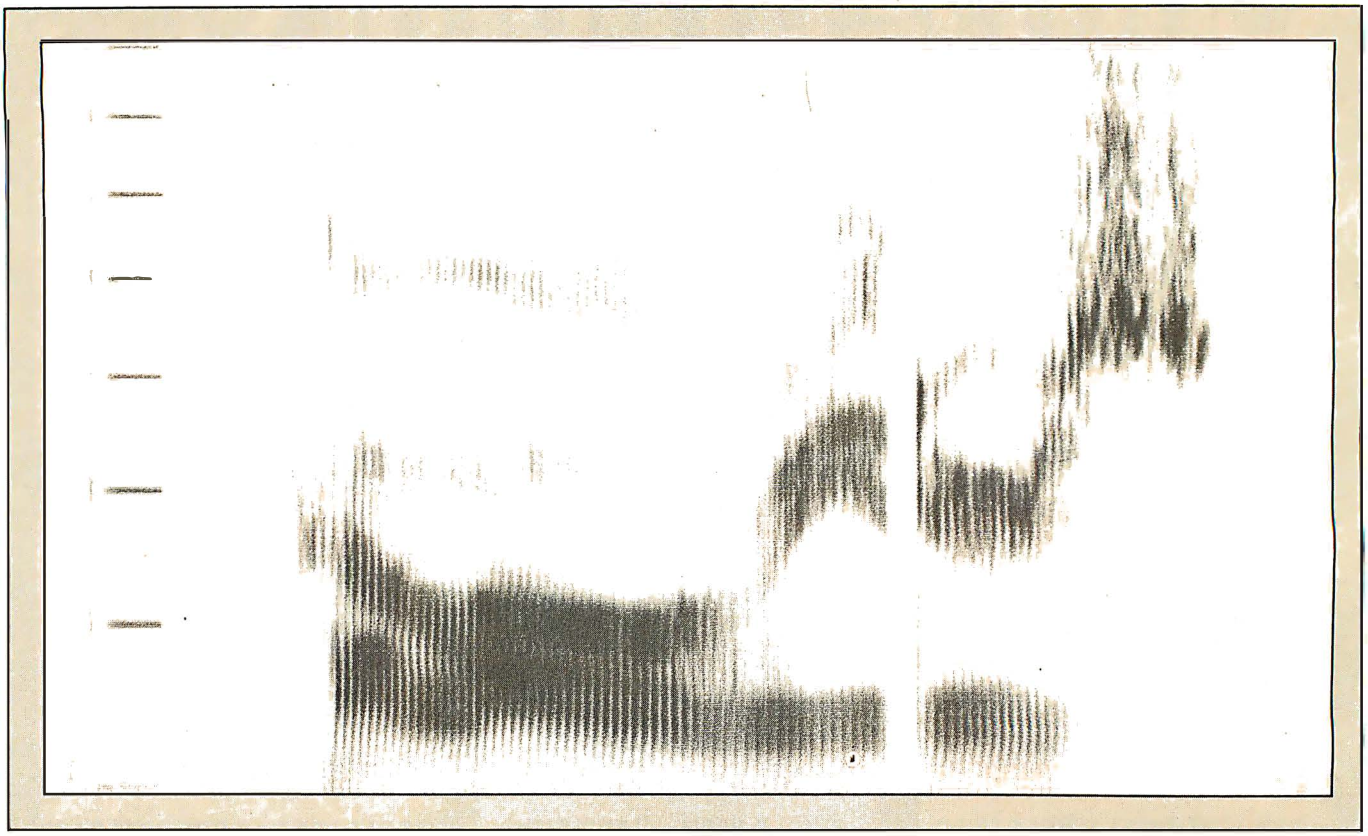


Photo 4: *A voiceprint of the message "hello readers." The X axis is time; the Y axis is frequency. Amplitude is displayed as a function of print density.*

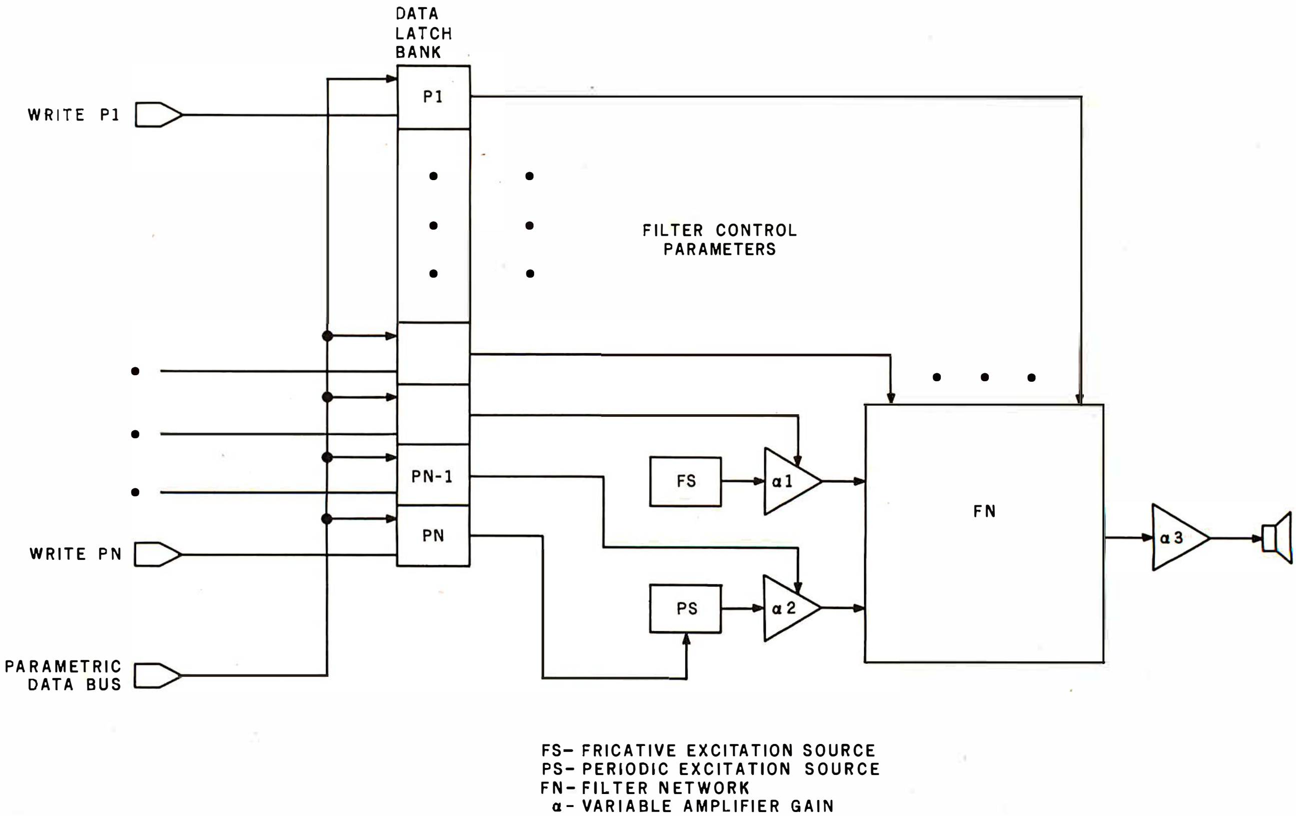


Figure 3: *A parametric speech synthesizer. The number of bits stored for each parameter depends on the needed range and the quantization tolerance of each parameter. In order to control this type of synthesizer, parametric data must be updated every 5 to 25 ms.*

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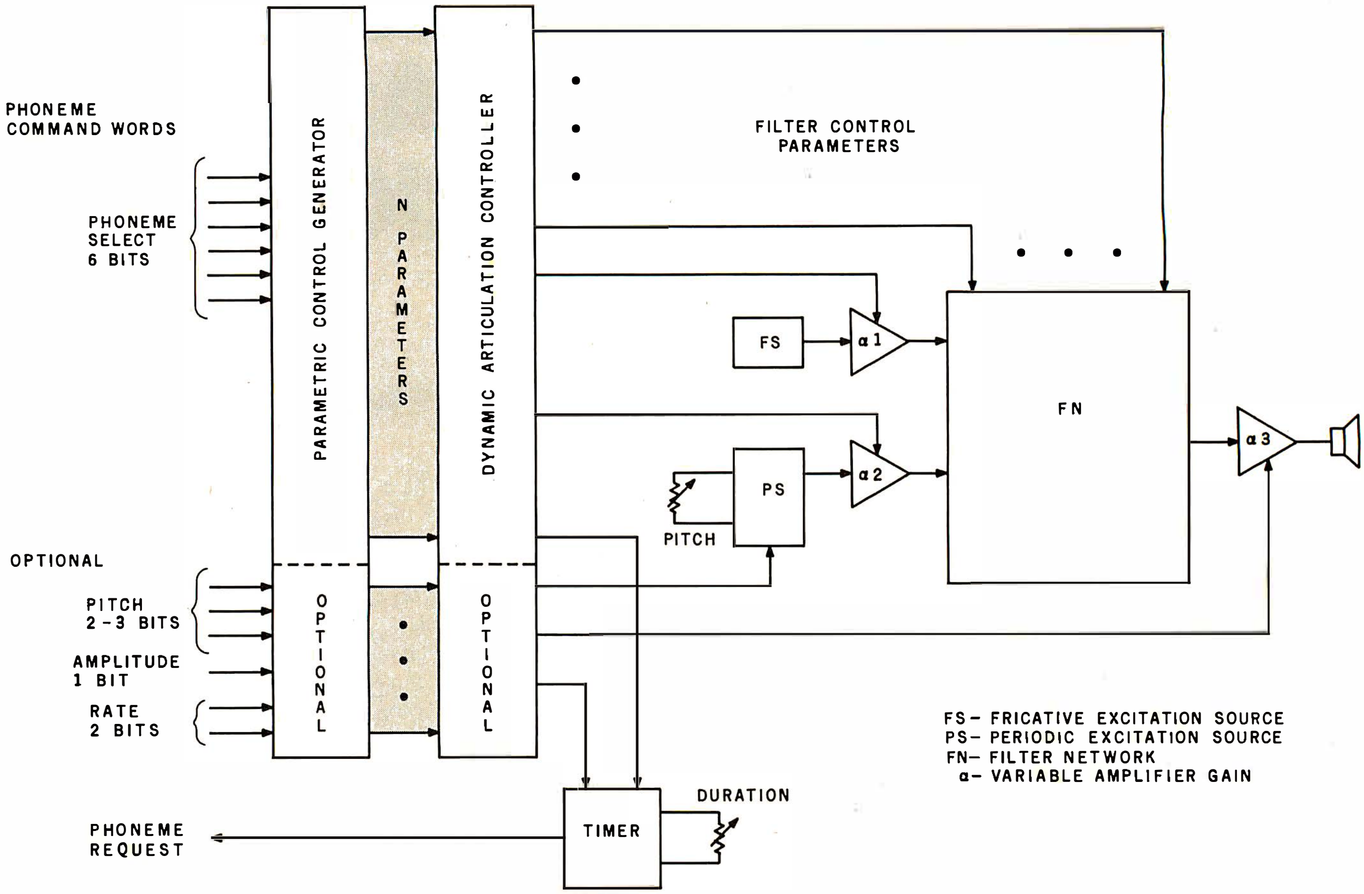


Figure 4: *A basic Votrax voice synthesizer. A phoneme command word is presented to the unit on the positive edge of the phoneme-request signal. The parametric control generator greatly reduces the synthesizer data consumption by calling out N parameters from only 6 bits. The dynamic-articulation controller generates continuous parametric transitions at phoneme boundaries.*

trol than a minimal unit because both utilize the same phoneme call-out procedure. A command word is used to signal phoneme production. The command word for a phoneme includes phoneme-select data and optional pitch, rate, and amplitude data. Typically, there are sixty-four phonemes produced, each requiring a 6-bit command word.

There are areas where a person must interact with a computer, but where the use of a visual output channel is inappropriate, unavailable, or ineffective.

A simple digital controller or microcomputer is all that is needed for vocabulary retrieval. In the phoneme synthesizer we have modeled here, the duration of each phoneme is controlled by an internal timer. At the end of an interval, the timer output momentarily goes low, requesting the interface to send the next phoneme command word. This phoneme request signal can be used to generate an interrupt request to a microprocessor or clock a command word out of a FIFO (first-in/first-out) buffer, an interface, or ROM (read-only memory). See figure 5 on page 176.

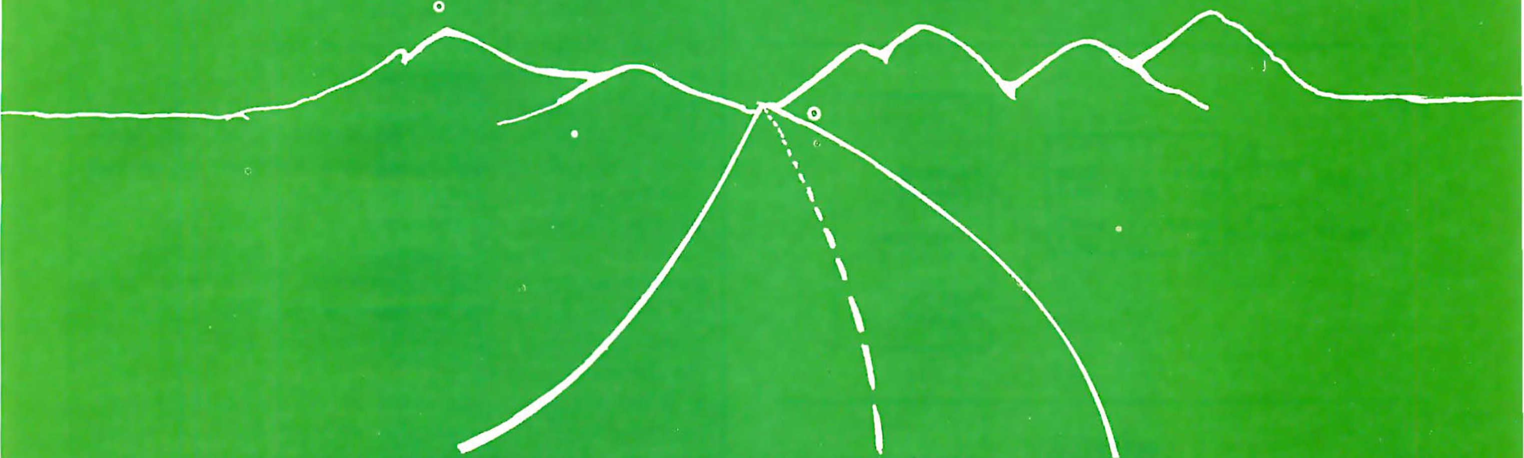
Several types of Votrax synthesizers are available. A recent addition to this family is the SC01, the first *single-chip* phoneme synthesizer; it represents a significant breakthrough in speech-synthesis technology. Contained in a 22-pin dual-inline package, this low-power CMOS (complementary metal-oxide semiconductor) synthesizer can be easily used on a printed-circuit board. Latched parallel inputs permit direct connection to a microcomputer data bus. A master clock input on the SC01 permits a variety of voice effects and highly textured sound effects to be generated.

Phonetic Programming

There are a few specific speech rules that dictate how phonemes are sequenced for intelligible speech output. Pronunciation guidelines and symbols, established by the IPA (International Phonetic Association), are often used to identify the phonemes and the altered or adapted units of sound (called *allophones*). These are used because the standard alphabetic characters may have more than one sound associated with a single symbol. Using phonetic guidelines, phonemes and/or allophones are combined to form the symbol sequence that represents the spoken word in a language. The written symbology, however, does not always directly translate into the sounds available in a phoneme synthesizer. Thus, a sequence of the synthetic phonemes constructed from the phonetic guide-

Text continued on page 180

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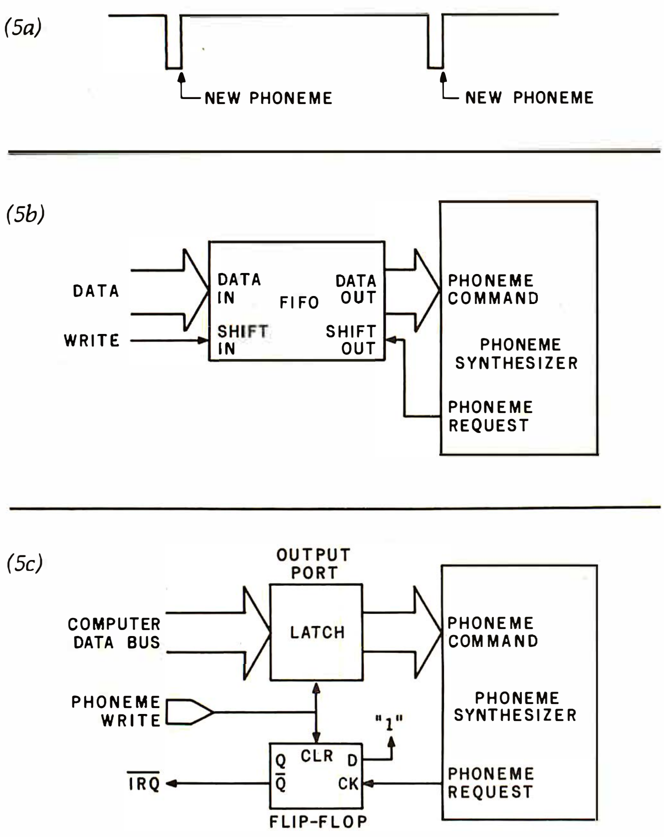


Figure 5: *Interface characteristics. A new phoneme is sent on the positive edge of the phoneme-request signal (5a). A FIFO (first-in/first-out) shift register (5b) provides an elastic buffer by shifting data in at a rate independent from the data being shifted out. Phoneme-request (5c) sets a flip-flop which generates an interrupt request (IRQ) to the microcomputer. When the computer writes the next phoneme command into the latch, the flip-flop is reset.*

Programming Phoneme Voice Synthesizers

There are a number of steps involved in programming a voice synthesizer. Initially, you will probably have to frequently refer to table 1, which lists symbols and example words which represent sounds:

- *Select the words to be programmed.*
- *Speak the words* out loud.
- *Select the appropriate phonetic symbols to represent the sounds in the words. The number of phonetic symbols you use should equal the number of sounds counted when the words are spoken.*
- *Enter the phoneme sequence into the synthesizer and listen to the speech output. Check the synthesizer's pronunciation for the appropriate duration of each syllable and rhythm of each word. The accent (or stress) placed on each word or syllable will help define the duration parameter.*
- *Select the longer-duration vowel phoneme for the accented syllable and the shorter-duration vowel phoneme for the unaccented syllable. Reenter the program and listen to it again.*
- *Adjust the program as many times as needed to achieve the desired pronunciation. This can be done by selecting different vowel-phoneme durations for the stressed vowel so that the durational relationship between the syllables sounds correct (see table 3). You can also adjust the sound by inserting a transition allophone between main vowels and consonants to achieve smooth pronunciation (see tables 2 and 3).*

A few examples are:

Word	Initial Program	Refined Program
move	*M-U-V*	*M-U1-U1-V*
family	*F-AE-M-L-E1*	*F-AE1-EH3-M-L-Y*
harvest	*H-AH-R-V-I3-S-T*	*H-AH1-UH3-R-V-I3-S-T*

Phonetic Symbols Votrax	IPA	Key Words	Phonetic Symbols Votrax	IPA	Key Words
B	b	bat - rub	NG	ŋ	ring - drink - single
D	d	dad - raid			
G	g	get - log	R	r	race - hard - hair
P	p	pack - flap - happy	L	l	low - late - call
T	t	tip - pat - asked	W	w	wake - always - when - quit
K	k	kill - kick	Y	j	yard - berry
DT	t	butter			
			A,A1,A2	e, e1, e2(eɪ)	tame - pail - make
Z	z	zap - haze - pans	E,E1	i, i1	beef - be - even
ZH	ʒ	pleasure - azure	I,I1,I2,I3	ɪ, ɪ1, ɪ2, ɪ3	pit - in - swim
V	v	van - pave	O,O1,O2	o, o1, o2	for - torn - bold
THV	ð	the - smooth - mother	U,U1	u, u1	move - school - June
J	dʒ	job - jazz - age			
			AE,AE1	æ, æ1	dad - plaid
S	s	soup - ask - pass - city	AH,AH1,AH2	ɑ, ɑ1, ɑ2	top - father
SH	ʃ	sheep - fish - action	AW,AW1,AW2	ɔ, ɔ1, ɔ2	call - paw
F	f	fake - cuff - phone - laugh	EH,EH1,EH3,EH3	ɛ, ɛ1, ɛ2, ɛ3	ready - leg - said
TH	θ	thing - math	ER	ɚ	third - heard - churn - over
CH	tʃ	cheese - march - match	UH,UH1,UH2,UH3	ʌ, ʌ1, ʌ2, ə	cup - random - around - under
H	h	hoop - have	OO,OO1	ʊ, ʊ1	took - put - good - could
			IU	(ju)	you - music
M	m	mat - dim	AY	(eɪ)	jade - made - claim
N	n	no - son	Y1	(ju)	you - music

Table 1: *Phoneme-conversion table. Shown are the Votrax and IPA (International Phonetic Alphabet) phonetic symbols and example words that show the pronunciation of each sound.*

	Front Vowels	Medial Vowels	Back Vowels	Mouth
Base Vowels	E I A EH AE	ER UH	U OO O AW AH	Closed ↑ Open
Vowel Allophones (durational)	E1 I1,I2,I3 A1,A2 EH1,EH2,EH3 AE1	UH1,UH2,UH3	U1 OO1 O1,O2 AW1,AW2 AH1,AH2	Closed ↑ Open
Vowel Allophones (sound)	Y1 (short, constricted E1) AY (short, relaxed E1)		IU (between the OO1 and U1)	Closed

Table 2: *Vowel phonemes are categorized here according to their place of production within the human vocal tract. Durational vowel allophones have a number following their symbol which indicates their durational relationship to the base vowel. (The suffix 1 indicates the longest duration; 3 indicates the shortest duration.) The Votrax phonetic symbols are used here.*

	Voiced	Voiceless	Group Name
Consonants	B,D,G	P,T,K,DT	Stop Plosives
	Z,ZH,V,THV,J	S,SH,F,TH,CH,H	Fricatives/Affricates
	M,N,NG		Nasals
	R,L,W,Y		Semivowels/Glides

Table 3: *Consonant phonemes are listed here according to their voicing quality and grouped according to the manner in which they are produced. Note that* all *vowels are classified as voiced phonemes.*

Phoneme Sequence	Usage
D-J	"j"-like sounds. Example: Judge = D-J-UH3-UH1-D-J
T-CH	"ch"-like sounds. Example: Church = T-CH-ER-R-T-CH
PA0	A short pause between words for rhythm. Example: Copy this list = K-AH1-UH3-P-Y-PA0-THV-I3-I2-S-L-I1-S-T Also used to separate stop-plosive sounds like "k"and "t" when they occur in sequence.Example: Correct = K-O2-R-EH2-K-PA0-T
PA1	The first and last phoneme in the completed sequence, used for maintaining the articulation of the first and last sound in the sequence. Example: The sequence is complete = PA1-THV-UH3-UH3-S-E1-K-W-EH1-N-T-S-PA0-I3-I3-Z-K-UH1-P-L-AY-Y-T-PA1
Z	Completes the phonetic sequence of a word being pluralized. Used only when the root word ends in a voiced sound, an S, or an SH. (See table 3 for a list of voiced sounds.) Examples: cans = K-AE1-AE1-N-Z balls = B-AW-L-Z goes = G-O1-U1-Z ashes = AE1-EH3-SH-I3-Z buses = B-UH3-UH1-S-I3-Z
S	Completes the phonetic sequence of a word being pluralized only when the root word ends in a voiceless sound other than S or SH. Examples: plants = P-L-AE1-EH3-N-T-S shops = SH-AH1-UH3-P-S laughs = L-AE1-EH3-F-S
D	Completes the phonetic sequence of a word with a past-tense suffix only when the root word ends in a voiced sound or a T. Examples: smiled = S-M-AH1-Y-UH3-L-D scored = S-K-O1-O2-R-D wanted = W-AH1-UH3-N-T-I3-D
T	Completes the phonetic sequence of a word with a past-tense suffix only when the root word ends in a voiceless sound other than T. Examples: typed = T-UH3-AH2-Y-P-T matched = M-AE1-EH3-T-CH-T washed = W-AW-SH-T missed = M-I3-I1-S-T

Table 4: *Since a number of phonetic sequences consistently produce intelligible speech, they can be classified as phonetic pattern rules. The most consistent patterns are shown here. Other phonetic patterns are more flexible, and many specific "sound effects" can be created through experimentation.*

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Phoneme Sequence	Usage
AE1-EH3	The vowel sequence, for words requiring the AE sound, that creates smooth pronunciation transition from the vowel into the following consonant. Also used to create duration for the stressed syllable. Examples: admit = AE1-EH3-D-M-I1-I3-T dash = D-AE1-EH3-SH
AE1-I3	The vowel sequence for words requiring the AE sound followed by NG or another nasal sound. Example: hanger = H-AE1-I3-NG-ER
AH1-UH3	The vowel sequence, for words requiring the AH sound, for smooth transition into other sounds. Examples: got = G-AH1-UH3-T father = F-AH1-UH3-THV-ER
S-S	Doubles the S phoneme when more duration is desired, as at the end of a phrase or sentence. Examples: gas = G-AE1-EH3-S-S witness = W-I1-I2-T-N-I3-S-S
D-J-J	Doubles the fricative portion of the "j" sound sequence for emphasis. Examples: Germany = D-J-J-ER-R-M-I3-N-Y large = L-AH1-UH3-R-D-J-J

Table 5: *In voice synthesis, it is often desirable to lengthen or shorten a vowel or consonant sound at the end of a syllable, word, phrase, or sentence. Shown here are several of the most common "tricks" for creating such effects.*

Text continued from page 174:

lines might produce an awkward, if not unintelligible, pronunciation of the word being translated. The pronunciation guidelines from any phonetic symbol system (IPA, *Webster's Dictionary, Thorndike's Dictionary*) can be used to establish a *basic* synthesized phoneme sequence, but *listening* is the final step used to determine the selections for a refined phoneme sequence (see text-box, "Programming Phoneme Voice Synthesizers," on page 176).

For the purposes of this article, all phonetic sequences are presented utilizing the Votrax Phonetic Symbol System. This system is used because it utilizes characters that are found on a standard computer terminal, as well as those needed for translation.

Phonemes

The sixty-four synthetic phonemes produced by a Votrax speech synthesizer are used here as the base synthetic-phoneme reference. The phonetic symbols representing these sounds and example words are listed in table 1 on page 176. There are twenty-five different consonant sounds, thirty-six basic vowel and vowel-allophone sounds, and two pause phonemes. The sixty-fourth phoneme is called a *zero-decode command phoneme*. It emits no sound, but can be used as a short interruption. When you select the appropriate synthetic sounds and place them in a specific sequence, the speech synthesizer can produce any word in the English language (as well as many other languages).

Vocabulary Storage

Vocabulary storage requirements are dependent on the

Listing 1: *An example assembly-language program designed to store a permanent vocabulary for voice synthesis in a read-only memory. The program generates a table of words which the user has entered and stores them sequentially in memory. It then produces a look-up table with entries that point to the corresponding word in the word-storage table.*

```
                        ; THIS DEMONSTRATES HOW AN ASSEMBLER
                        ; CAN PACK A WORD TABLE AND GENERATE
                        ; THE APPROPRIATE WORD LOOK-UP TABLE

                        ;       THIS IS THE LOOK-UP TABLE

      1000      >               ORG 1000H
 1000 00200820>                 WORD    ACCESS,BREAK
 1004 0D201220>                 WORD    CLOSE,DISK
 1008 17201B20>                 WORD    FREE,LEFT
 100C 20202420>                 WORD    NEW,STOP
 1010 29202E20>                 WORD    TIME,USER
 1014 34203B20>                 WORD    VALUE,XXX

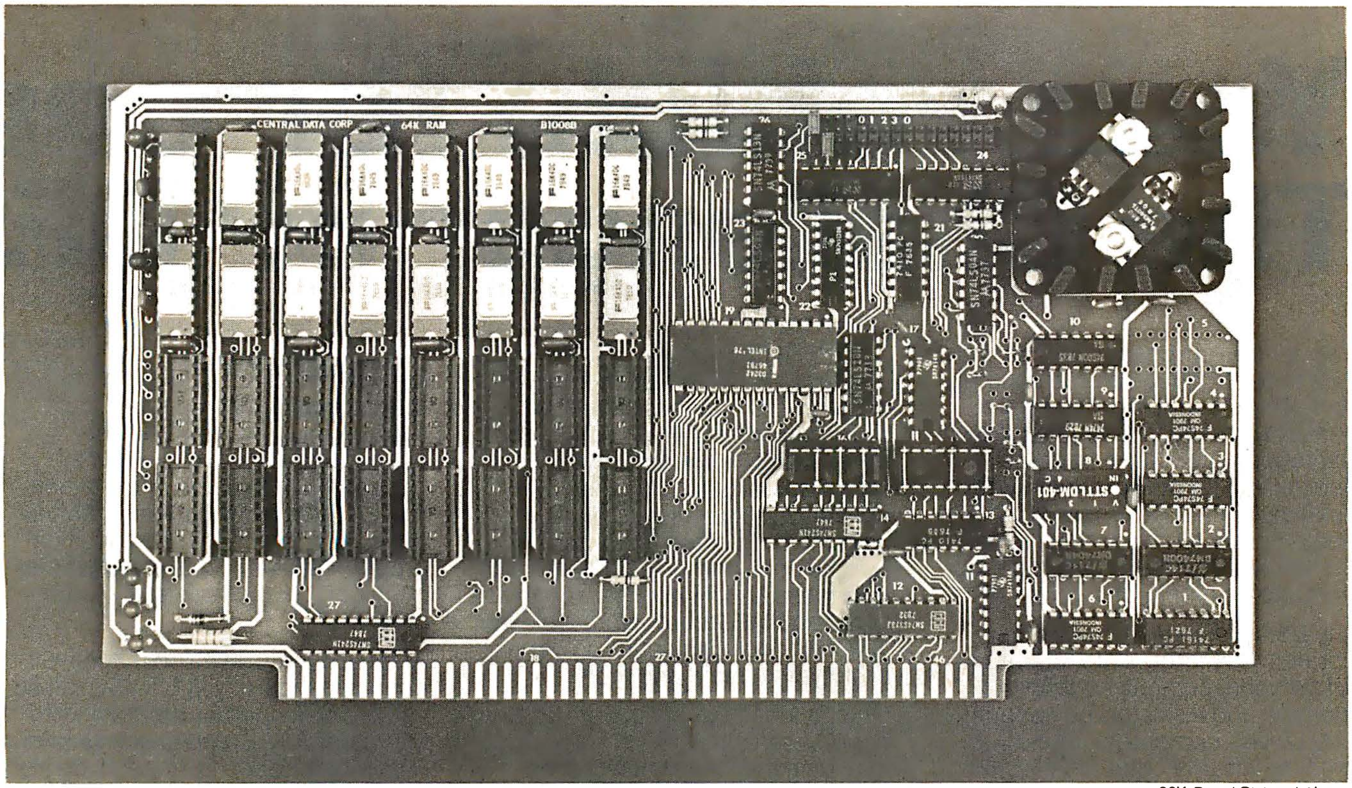
                        ;       THIS TABLE WILL CONTINUE FOR AS MANY
                        ;       ENTRIES AS DESIRED OR MEMORY ALLOWS

                        ; THIS IS THE WORD STORAGE TABLE, IT CAN BE
                        ; PLACED WHERE YOU DESIRE. WORDS APPEAR IN THE
                        ; ABOVE ORDER INORDER TO USE THE START OF THE
                        ; NEXT WORD AS THE STOP FLAG OF THE CURRENT WORD

      2000      >               ORG 2000H
 2000 39350B30    ACCESS  BYTE AE1,EH3,K,PA0,S.,EH1,EH3,S.
 2004 13333513
 2008 0212002A    BREAK   BYTE B.,R.,A1,AY,K
 200C 0B
 200D 0B0C0F15    CLOSE   BYTE K,L.,O1,U1,Z.
 2011 1A
 2012 04092313    DISK    BYTE D.,I1,I3,S.,K
 2016 0B
 2017 06120526    FREE    BYTE F,R.,E1,Y
 201B 0C333506    LEFT    BYTE L.,EH1,EH3,F,T
 201F 14
 2020 0E281515    NEW     BYTE N,IU,U1,U1
 2024 13143B38    STOP    BYTE S.,T,AH1,UH3,P.
 2028 10
 2029 143B3526    TIME    BYTE T,AH1,EH3,Y,M.
 202D 0D
 202E 19281515    USER    BYTE Y1,IU,U1,U1,Z.,ER
 2032 1A2F
 2034 1639350C    VALUE   BYTE V,AE1,EH3,L.,Y1,IU,U1
 2038 192815
 203B 00          XXX     BYTE    0

                        ; NOTICE: THIS SCHEME DOESNT CARE HOW MANY
                        ; BYTES ARE ALLOCATED TO EACH WORD. THERE ARE
                        ; MANY VARIATIONS ON THIS SCHEME.
                        ; PARTIAL PHONEME EQUATES BELOW

      0000        A1      EQU 0
      0039        AE1     EQU 57
      003B        AH1     EQU 59
      002A        AY      EQU 42
      0002        B.      EQU 2
      0004        D.      EQU 4
      0005        E1      EQU 5
      0033        EH1     EQU 51
      0035        EH3     EQU 53
      002F        ER      EQU 47
      0006        F       EQU 6
      0009        I1      EQU 9
      0023        I3      EQU 35
      0028        IU      EQU 40
      000B        K       EQU 11
      000C        L.      EQU 12
      000D        M.      EQU 13
      000E        N       EQU 14
      000F        O1      EQU 15
      0010        P.      EQU 16
      0012        R.      EQU 18
      0013        S.      EQU 19
      0014        T       EQU 20
      0015        U1      EQU 21
      0038        UH3     EQU 56
      0016        V       EQU 22
      0026        Y       EQU 38
      0019        Y1      EQU 25
      001A        Z.      EQU 26
      0030        PA0     EQU 48
                          END
```



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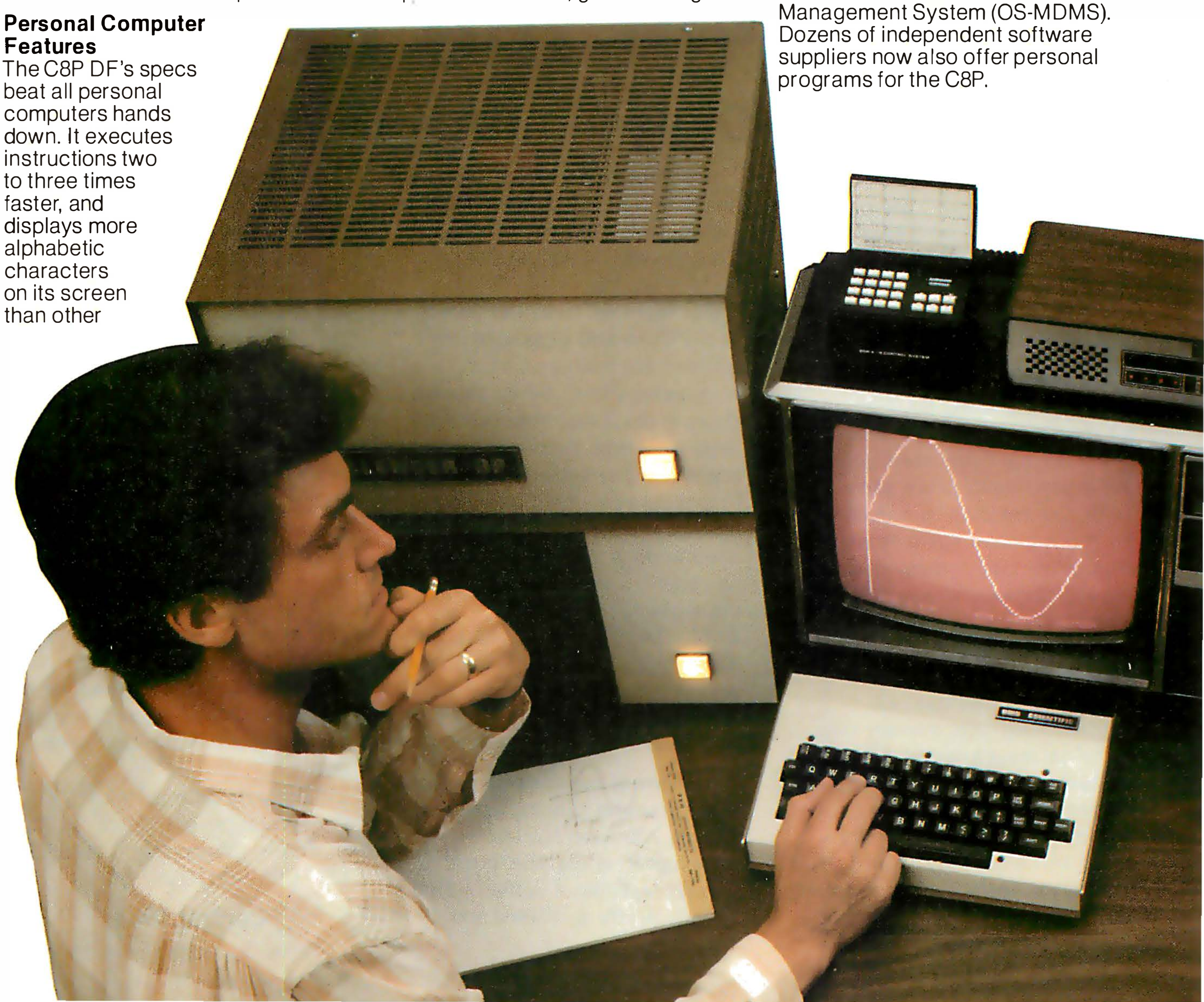
The C8P is unique in that it incorporates the features of state-of-the-art personal computers, with the memory and disk storage capacity of business computers, along with the "mainframe" bus architecture and open ended expansion capability of industrial control computers.

Personal Computer Features

The C8P DF's specs beat all personal computers hands down. It executes instructions two to three times faster, and displays more alphabetic characters on its screen than other models. It has upper and lower case and graphics in 16 colors. The C8P's *standard* I/O capabilities are far more extensive than any other computer, with joystick and keypad interfaces, sound output, an 8-bit D/A converter, 16 parallel I/O lines, modem and printer interfaces, AC remote control and security monitor interfaces and a universal accessory port that accepts a prom blaster, 12-bit analog I/O module, solderless prototyping board and more.

Ohio Scientific offers a large library of personal applications programs, including exciting action games such as Invaders and Star Trek, sports simulations, games of logic and educational games, personal applications such as biorhythms, calorie counter, home programs such as checking and savings account balancers and a home budgeter just to name a few. A new Plot BASIC makes elaborate animations easy, and music composition program allows you to play complex multi-part music through the computers DAC.

At the systems level the machine comes standard with OS-65D, an advanced disk operating system with Microsoft BASIC and an interactive Assembler Editor. Optional software includes UCSD PASCAL and FORTRAN and an Information Management System (OS-MDMS). Dozens of independent software suppliers now also offer personal programs for the C8P.



puter explorations.

Business Computer Features
The C8P DF utilizes dual 8″ floppy disk drives which store up to eight times as much information as personal computer mini-floppies, and an available double-sided option expands capacity to 1.2 megabytes of on-line storage. The C8P DF is compatible with Ohio Scientific's business computer software, including OS-65U an advanced operating system, and an Information Management System (OS-DMS) with supplementary inventory, accounting, A/R-A/P, payroll, purchasing, estimation, educational grading and financial modeling packages. The system also supports word processing (WP-3) and a fully integrated small business accounting system (OS-AMCAP V1.6). The C8P DF's standard modem and printer ports accept high-speed matrix printers and word-processing printers directly.

Home Control and Industrial Control
The C8P DF has the most advanced home monitoring and control capabilities ever offered in a computer system. It incorporates a real time clock and a unique FOREGROUND/BACKGROUND operating system which allows the computer to function with normal BASIC programs, at the same time it is monitoring external devices. The C8P DF comes standard with an AC remote control interface, which allows it to control a wide range of AC appliances and lights remotely, without wiring, and an interface for home security systems which monitors fire, intrusion, car theft, water levels and freezer temperature, all without messy wiring. In addition, the C8P DF can accept Ohio Scientific's Votrax voice I/O board and/or Ohio Scientific's new universal telephone interface (UTI). The telephone interface connects the computer to any telephone line. The computer system is able to answer calls, initiate calls and communicate via touch-tone signals, voice output or 300 baud modem signals. It can accept and decode touch-tone signals, 300 baud modem signals and record incoming voice messages. These features collectively give the C8P DF capabilities to monitor and control home functions with almost human-like capabilities.

For process control applications, a battery back up calendar clock with automatic computer restart capabilities is available. Ohio Scientific's unique accessory ports allow the connection of a nearly unlimited number of 48 line parallel I/O cards and 12-bit high speed instrumentation quality analog I/O modules to the computer by inexpensive 16-pin ribbon cables.

Exploring New Frontiers
Ohio Scientific's vocalizer software processes normal BASIC print statements with conventional spellings and speaks them clearly in real-time on computers equipped with the UTI (CA-15B or CA-14A). This voice output capability, combined with the C8P's remote control, remote sensing, telephone interface capabilities and reasonable cost open up new frontiers for computer applications.

Documentation
The C8P DF is not a beginner's computer and doesn't come with beginner's documentation. However, Ohio Scientific does offer detailed documentation on the computer which is meaningful for experts, including a Howard Sams produced hardware service manual that includes detailed block diagrams, schematics, parts placement diagrams and parts lists. Ohio Scientific is now also offering fully documented Source Code in machine readable form for OS-65D, the Challenger 8P's operating system allowing experimenters and industrial users to customize the system to their specific applications.

What's Next?
Ohio Scientific is working on a speech recognizer to complement the UTI system, with a several hundred word vocabulary. The company is also developing an 8 megabyte low-cost, add-on hard disk for use in conjunction with natural language parsing to further advance the state-of-the-art in small computers. The modular bus architecture of the C8P assures system owners of being able to make use of these new developments as they become available just as the owner of a 1976 vintage Challenger can directly plug in voice output, the UTI and other current state-of-the-art OSI products.

The C8P DF with dual 8″ floppies, BASIC and two operating systems costs about $3000, only slightly more than you would pay for a dual mini-floppy equipped personal computer with only a fraction of the capabilities of the C8P.



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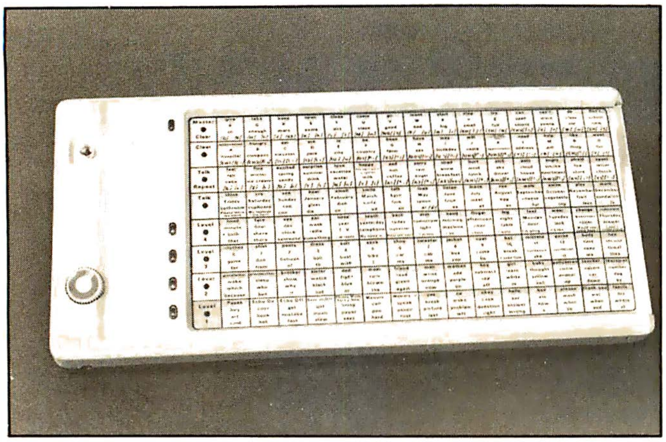


Photo 5: *A communicator for the verbally impaired. The Phonic Mirror HandiVoice HC-110 is a battery-operated speech synthesizer controlled by a microprocessor. The user can select from its 500 word/phrase vocabulary by touching the keypad.*

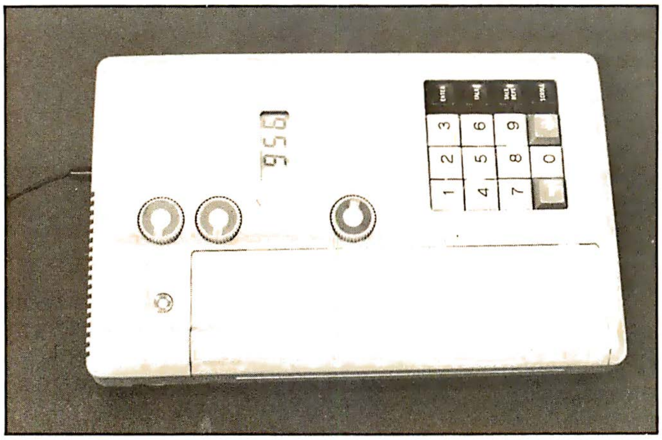


Photo 6: *The Phonic Mirror HandiVoice HC-120 is an advanced version of the voice synthesizer shown in photo 5. It has a 1000 word/phrase vocabulary selected by entering a 3-digit numeric code. Paralyzed users can operate the unit through the use of a paddle switch and a scroll mode.*

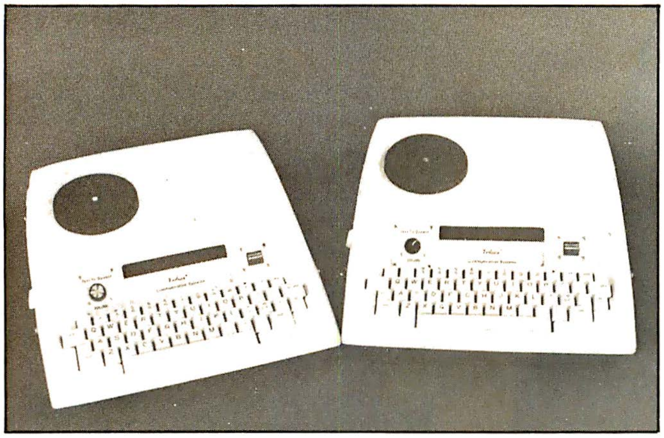


Photo 7: *Talking typewriters for use by the verbally impaired. The units, which use phonemes, have a virtually unlimited vocabulary.*

Listing 2: *A driver program in BASIC which accesses the vocabulary as stored by the program shown in listing 1. The end of a word is detected by the starting address of the adjacent word in the table.*

```
100 '       SPEECH OUTPUT SUBROUTINE IN BASIC
110 '       PHONEMES ARE SELECTED FROM THE WORD
120 '       POINTED TO BY WN%
130 '
140 X = 1000H + 2 * WN%                    : ' CALCULATE LOOK-UP ADDRESS
150 Y = PEEK(X) + 256 * PEEK(X+1)          : ' LOOK-UP WORD START
160 Z = PEEK(X+2) + 256 * PEEK(X+3)        : ' LOOK-UP NEXT WORD START
170 FOR X = Y TO Z-1                       : ' SET UP LOOP ITERATIONS
180 OUT SPEECH,PEEK(X) : NEXTX             : ' OUTPUT A PHONEME
190 RETURN                                 : ' EXIT
```

number of words in the vocabulary and the number of bits in a phoneme-command word. For example, a vocabulary of 100 words using a 6- to 8-bit command word to represent each phoneme will require 600 bytes of storage. A 1000-word vocabulary will require 6000 bytes of storage. A 12-bit command word will require 900 to 1200 bytes for a 100-word vocabulary and 9000 to 12,000 bytes for a 1000-word vocabulary (depending on the packing techniques).

When using a phoneme synthesizer with a 6-bit command word and a high-level computer language that allows literal strings to be assigned to a variable, vocabulary storage can be embedded within the program statements by using ASCII strings. This is because a 6-bit command word has only sixty-four possible commands, where there are at least 64 printable ASCII characters. A word or phrase is assigned to a string variable immediately before being sent to a speech-output routine. This routine pulls characters out of the string variable one at a time and sends them to the synthesizer. This technique is suitable for small vocabulary requirements. With large vocabularies, there tends to be word duplication because the storage unit is a sentence or phrase.

A technique better suited for handling large word bases is the assignment of the phoneme string for a single word to a subscripted string variable. This avoids the word duplication experienced by the previous technique and saves memory (provided that the language stores character strings with no wasted space). To generate a sentence using this technique, a sequence of variable subscript numbers is passed to a routine which calls up the indicated variables. Phoneme strings are then removed from the variable and sent to the synthesizer.

For permanent vocabularies stored in ROM (read-only memory) or loaded into programmable memory from a disk file, a word-address look-up scheme works well. This is done by generating a table of words stored sequentially in a portion of the memory. You then produce a look-up table whose entries point to a word in the word-storage table. The number of the look-up-table entry corresponds to the number assigned to the word (eg: the fifth entry in the look-up table will point to the fifth word in the word table). These tables can be generated easily (see listing 1). Sentences are called out in the same fashion as the previous scheme.

The assembler scheme works well with any size phoneme-command word, since it does not care how many bits are used to represent a phoneme. However, the driver program must know whether to pull 1, 1½, or 2 bytes per phoneme. Listing 2 shows a driver program in BASIC to access the vocabulary in listing 1. Note that the

end of a word is detected by the starting address of the adjacent word in the table.

Applications

In the field of computer technology alone, there is tremendous potential for the use of speech output. Through voice synthesis, applications can expand into areas formerly closed. These are areas where a person must interact with a computer, but where visual output is inappropriate, unavailable, or ineffective.

Currently, a blind person who wishes to use a computer must rely on a sighted person to relay information from a video display or printer. To eliminate this dependency, a terminal for the blind can be built to incorporate voice synthesis. Several such terminals are beginning to appear on the market.

Another situation where speech output is desirable is a warehousing/dispatching system. It is not often cost-effective to place terminals around a large warehouse to list pending tasks. A better method is speech output from a computer connected to a radio link, which dispatches a worker carrying a pocket receiver/transmitter. Similar systems are in use or being developed today.

Another area where computers are presently ineffective is in interfacing with the nonreading population. Such is the case when the users are preschool children or nonreading adults. They are the prime candidates for using CAI (computer-aided instruction) as a supplement to their education. Applications such as computerized testing and evaluation of children would invite advancements in the educational field if a speech-output channel was used.

Synthetic speech applications are not limited to merely the computer peripherals mentioned. When used with a small, dedicated microcomputer or digital controller, a stand-alone device can be produced. Such is the case with a reading machine for the blind.

A second type of stand-alone speech system is a communicator for the verbally impaired. A battery-operated microcomputer system and a speech synthesizer can provide a voice for individuals stricken with neurological or physical disorders which impair the human speech mechanism (see photos 5 and 6).

Other applications for voice synthesis are in the area of entertainment electronics. Talking card games, chess games, and video games are beginning to use voice synthesis. Many of these applications are made possible by LSI (large-scale integration) circuits such as the Votrax SC01 single-chip voice synthesizer.

The interface of man-to-machine will provide a challenge for the 1980s. Speech synthesis will play an important role in the future of computer technology. ■

Editor's Note: *One of the first voice-synthesis products for consumers was Texas Instruments Speak & Spell, which uses a ten-stage lattice filter to simulate the human vocal tract. In the fall of 1980, as part of the continuing trend toward integrating voice synthesis into everyday products, MB Electronics (a subsidiary of Milton-Bradley) introduced an electronic game called "Milton." The game is controlled by a Texas Instruments TMS-1000-series 4-bit microprocessor and utilizes a custom voice-synthesis integrated circuit designed by MB engineers....*SM

Technical Forum

Nonlinearities in Illumination

Christopher Terry, 324 E 35th St, New York NY 10016

I certainly do not wish to be hastily critical of an excellently documented and very interesting project. However, my points may help constructors to carry their experiments with computer-controlled light dimmers a bit further and to avoid disappointment with the results.

The dimmer, as described in John Gibson's "A Computer-Controlled Light Dimmer" (January 1980 BYTE, page 56), will certainly fade a lamp from blackout to full brightness or vice versa. However, it is important to realize that a smooth, steady fade cannot be obtained by incrementing the delay count in equal steps throughout the fade time. Linear change of this kind is an analog of the steady motion of a dimmer slide, whose scale is normally calibrated from 0 to 10 in equal divisions. On the other hand, the response characteristics of the digital dimmer, of incandescent lamps, and of the eye itself, are all highly nonlinear.

Figure 1 shows the curve of light output (expressed as a percentage of maximum light output in lumens) versus voltage applied to a lamp (expressed as a percentage of the rated, normal operating voltage). Data for this curve was taken from the Sylvania GTE *Lighting Handbook*

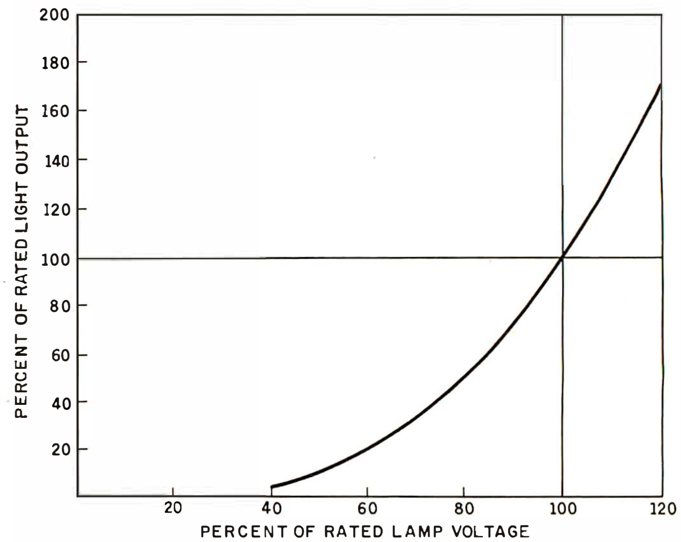


Figure 1: *The nonlinear response of light output versus the voltage applied to an incandescent lamp. Although the curve is almost linear above the 60% illumination point, an incandescent bulb can require as much as 40% of rated voltage to illuminate at all. Note that driving lamps with higher-than-rated voltage will reduce life drastically.*

and is valid for most incandescent lamps. The most linear part of the curve is above the 60% illumination point. The nonlinearity is even more apparent in figure 2, which shows a standard calibration curve for theatrical SCR (silicon-controlled rectifier) dimmers controlling 120 V lamps from a 120 V RMS (root mean square) supply. The percentage of light output is also shown on the voltage axis. Note that 70 V RMS must be applied before the brightness reaches 10%, and that raising the voltage from 80 V to 109 V increases the brightness from 25% to 75%.

Figure 3 shows the predicted RMS voltage applied to the load for trigger-delay angles from 0° to 179°, and also the percentage of light output corresponding to the applied voltage. The *angle versus volts* curve was derived from the formula given in the *SCR Handbook* for triacs and back-to-back SCRs. The formula is:

$$V_{LOAD(RMS)} = \frac{E_p}{\sqrt{2\pi}}(\pi - a + 0.5(\sin 2a))^{0.5}$$

where a (the firing angle) is in radians (not degrees), and E_p is the peak value of the supply.

Evaluating this equation with a BASIC program gave excellent experimental results. Using a 46 μs clock to drive the counter, computed values agree quite closely with this curve. (The true time for 1° per pulse is 8333/180=46.294 μs, but the 46 μs clock is easily derived from a 1 MHz system clock and is only 1° off at 160°.)

The human eye's response, too, is very nonlinear. When the area lit by a controlled lamp is surrounded by constant illumination at 20% of the maximum brightness of the controlled lamp, the *apparent* brightness of the controlled lamp follows a Munsell curve somewhat similar to the Munsell curve relating the apparent loudness of a sound to its frequency and power.

Because of these effects, theatrical dimmers, which receive a linear control voltage from the slide potentiometer, contain internal curve-generating circuits that cause the dimmer output to follow either the *linear light curve* of figure 2, or more usually the *square law curve*. The manner in which these curves relate linear dimmer motion to apparent light output is shown in figure 4—it is evident that the square law curve provides the most linear relationship, at least for the theatrical stage.

The eye is most sensitive in the region from 25% to 85% of maximum light output. In this range, a sudden jump of 1 V produced by a delay count change is perceptible, and jumps of 1.5 V to 2 V are quite obnoxious dur-

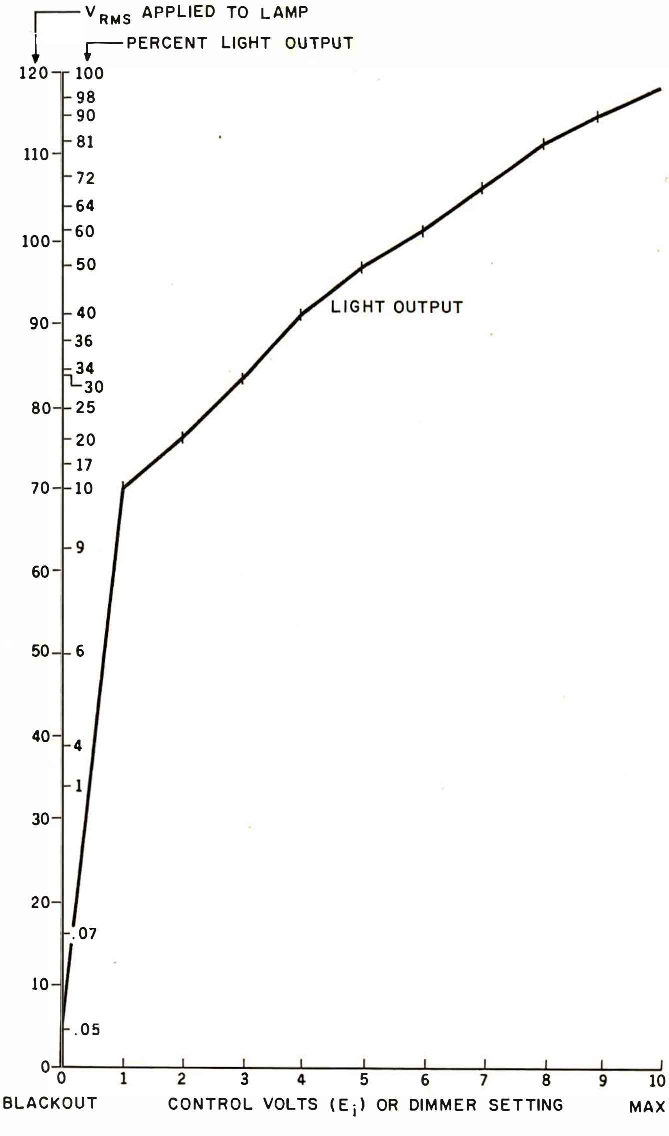


Figure 2: *Calibration curve for theatrical lamp dimmers. The control voltage is interpreted by the dimmer to produce a linear-seeming response. Note that the voltage actually applied to the lamp is* not *linear, but is related to the response of the lamp to voltage and the response of the human eye to light.*

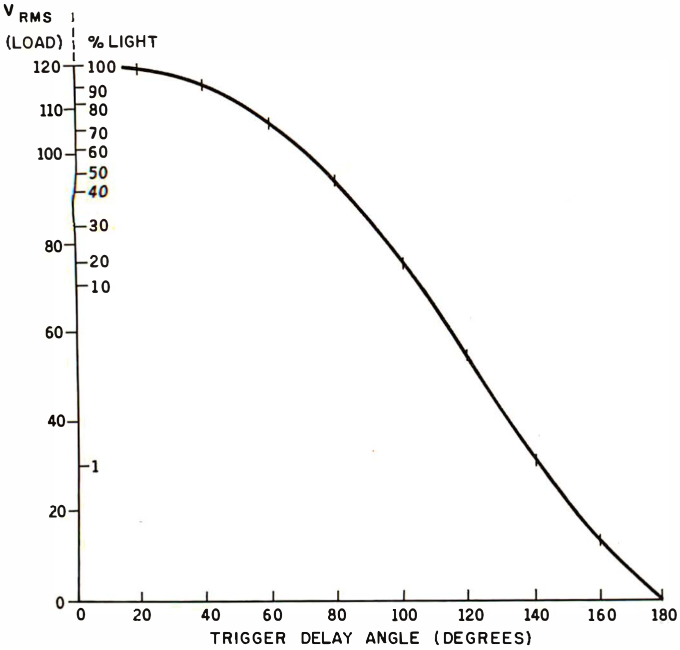


Figure 3: *Effect of trigger-delay angle on the RMS voltage applied to the load of a thyristor-type dimmer. Plotted along with the percent of light output expected from an incandescent lamp, this curve is valuable for computer-controlled dimmer applications. This curve is based on calculations made with a 46 µs clock, which may be developed from a 1 MHz system clock.*

ing a long fade (eg: 20 seconds or more). To obtain a smooth fade, it is necessary that the linear timing pulses are translated to delay counts that will generate the square law curve. Also, since sudden changes are inevitable with a digital dimmer, it is desirable that the magnitude of each incremental change is small, especially during a long fade. This implies increasing the number of steps so that smaller, more frequent voltage jumps *will* better approach the continuous change of an analog dimmer. So far, I have obtained the best results by using an 8-bit delay counter, which is not started until after a delay of 20° (920 µs); the range from 20° to 160° is then divided into 256 steps. The actual value loaded into the counter is obtained from a software table that converts linear increments to values that follow the square law.

I have some cautionary notes to add, based on my own experiments. Triacs are much more persnickety and difficult to control than a pair of back-to-back SCRs with a bridge to steer the trigger pulse. Unless great care is taken in the design of the *dv/dt* and *di/dt* damping networks, triacs generate a much larger amount of RFI (radio frequency interference), are more subject to "pulling," are liable to be unpredictable and have infuriating interaction between channels on the same AC power phase. I have some doubt as to whether the simple RC (resistor/capacitor) damping networks shown by John Gibson in his figure 9 will support multiple channels, all changing at different rates in different directions, without interaction. A damped inductive filter is recommended by General Elec-

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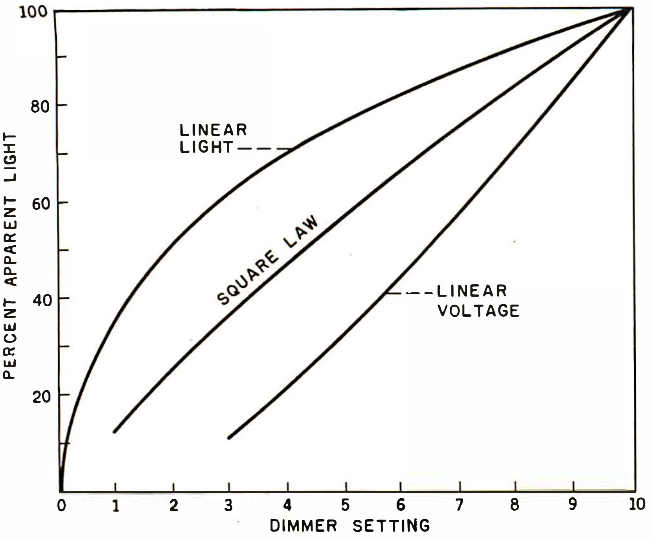


Figure 4: *Theatrical dimmer setting versus apparent light output. Internal curve-generating circuitry of most theatrical dimmers follows either the linear light curve or the square law curve, as shown.*

tric, and I have found this type more effective in reducing RFI and interaction between channels. (See figure 5.)

Also, triacs seem to be more vulnerable to spike overloads than SCRs. This becomes important when you realize that applying full voltage to a cold lamp filament, which has a very low resistance, causes an inrush current

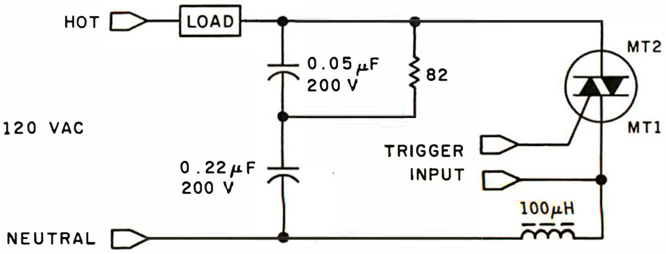


Figure 5: *A damped inductive filter for triac dimmers. By removing RFI with an effective filter arrangement, interaction between dimmers can be reduced. This is especially important when multiple channels are used to control lamps at differing rates and in different directions.*

spike that may peak at three to six times the normal full-brightness operating current of the lamp. While low-wattage lamps warm quickly, the thermal inertia of lamps rated at 200 W or more may allow the spike to be several milliseconds in duration and cause damage to the triac. Triacs are particularly vulnerable to such spikes, and I make it a rule never to load a triac to more than half its rated maximum current in applications where full voltage could be applied to a cold filament.

Theatrical dimmers reduce inrush problems by keeping filaments warm with a blackout voltage of 12.5 V RMS. You may find that this results in a perceptible filament glow. If you reduce the blackout voltage to 6 V, you will kill the glow while still keeping the filaments warm enough to avoid inrush problems.

Finally, I suggest that readers interested in precise light level control and color mixing should consult the following books:

- *The SCR Manual*, 4th Edition. General Electric Co, 1967 or later. This is the basic bible on proportional control and SCR/Triac circuit design.
- *Sylvania GTE Lighting Handbook*. Sylvania Co, any recent edition. This is a handy reference book on incandescent lamps, fixtures, and space lighting principles.
- *CORTLI (Computer Output of Real Time Lighting Information)*, The Mimi Garrard Dance Company, Soho Loft Theatre, 155 Wooster St, New York NY 10012, 1978. (The cost is $10.) This describes a complete lighting system using digital dimmers under the control of an 8080-based microcomputer: about fifty pages on how it came to be, over one hundred pages of detailed technical information, including detailed schematics and software listings in 8080 assembly language, and some operating information. It's very readable, and you get a tremendous amount of both solid information and speculation about future possibilities; likewise, it's an excellent source book for the money. The system works really well, too! I have seen it in action a number of times. ■

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74LS15	.30	74LS173	1.19
74LS20	.30	74LS174	.75
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74LS27	.35	74LS191	1.15
74LS28	.39	74LS192	1.15
74LS30	.30	74LS193	1.15
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270pf	.07	.06	.04
330pf	.07	.06	.04
470pf	.07	.06	.04
.001mf	.07	.06	.04
.0022mf	.07	.06	.04
.0033mf	.07	.06	.04
.0047mf	.07	.06	.04
.01mf	.07	.06	.04
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.33mf	35v	.35	.30	.26
.47mf	35v	.35	.30	.26
.68mf	35v	.35	.30	.26
1mf	35v	.35	.30	.26
1.5mf	35v	.45	.39	.33
2.2mf	35v	.45	.39	.33
3.3mf	35v	.50	.42	.36
4.7mf	25v	.50	.42	.36
4.7mf	35v	.65	.56	.44
6.8mf	35v	.65	.56	.44
10mf	25v	.85	.72	.61
10mf	35v	1.19	1.00	.84
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22mf	25v	1.30	1.09	.92
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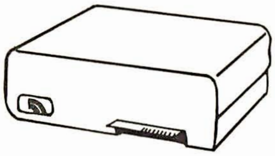


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Build a Null Modem

Robert Haar, 1675 Thetford Rd, Towson MD 21204

When connecting computers, terminals, and communication equipment, it is sometimes useful to have a device called a null modem. To understand what a null modem is and why you might need one, it is first necessary to know what a modem does and what is meant by the term RS-232C serial interface.

Modems

You probably have some idea of what a modem does. It allows computers and terminals to communicate over phone lines. This is done by converting serial binary data (individual bits transmitted one bit at a time) into audible tones that can be sent over normal telephone lines. Another modem at the opposite end translates these tones back into a stream of bits, which is then regrouped into 8-bit bytes. Figure 1 is a diagram of this setup. The most common type of modem is called *Bell 103A compatible*.

RS-232C Serial Interface

The term *RS-232C* refers to a standard that specifies the connection between a modem and either a computer or a terminal, covering the physical, electrical, and functional aspects of that interface. We are most familiar with the physical side of this standard since it describes the ubiquitous 25-pin D-shaped connector (the DB-25) that is used on most terminals and computer serial I/O (input/output) ports. The electrical aspects of the standard specify what kind of electrical signals can be applied to the pins of such a connection. The functional part says what the signals on each pin are supposed to mean.

The modems shown in figure 1 are called DCE (data-communication equipment), while both the terminal and the computer are called DTE (data-terminal equipment). It makes no difference whether a unit is a terminal, a computer, or anything else—if it connects to a modem, it is DTE. One pin in the RS-232C connector is designated as a *transmit-data* line. This pin carries serial data from the DTE to the modem (DCE). Another pin is called *receive-data,* and its data goes in the other direction. It is important to note that the transmit/receive designation is always defined in reference to the DTE-to-DCE connection.

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Null Modems

The name "null modem" suggests a black box that looks like a modem but doesn't do anything. To see why you would need an "empty" modem, suppose that the terminal and the computer shown in figure 1 are in the same room and you wish to connect them together. You might be able to physically connect them if you have a cable with a DB-25P plug (male connector) on the end and the other has a corresponding socket, the DB-25S. But if both of them have been wired to connect to modems, you have a problem. Both will be sending information on the same transmit-data pin and both will be expecting to receive data from the other on the same receive-data pin. This would be equivalent to the effect of talking to someone on the telephone while the telephone handset is upside down. It just won't work.

The simplest variety of null modem cross-connects the transmit- and receive-data lines as well as connecting the ground pins, which are required to establish a voltage reference for the other signals. In many instances, this is all you will need to allow the terminal and computer to talk to each other. In some cases, either the terminal or the computer requires other signals in addition to the data and ground lines. Table 1 lists the most commonly used pins in the RS-232C interface, along with their usual abbreviations and meanings.

Pin Number and Name	Function
1 (AA)	FG (frame ground), protective ground connection.
2 (BA)	TD (transmit data), from DTE to DCE.
3 (BB)	RD (receive data), DCE to DTE.
4 (CA)	RTS (request to send), the DTE asking permission to send to the DCE.
5 (CB)	CTS (clear to send), the DCE granting transmit permission.
6 (CC)	DSR (data set ready), indicates that the DCE is powered up.
7 (AB)	SG (signal ground), ground reference for the TD and RD signals.
15 (DB)	TC (transmit clock), clock used to generate the serial transmitted data (DCE to DTE).
17 (DD)	RC (receive clock), clock for received data (DCE to DTE).
20 (CD)	DTR (data terminal ready), indicates that the DTE is powered up.
22 (CE)	RI (ring indicator), says that the incoming phone line is ringing; used with modems with answer capability.
24 (DA)	XTC (external transmit clock), like TC but from the DTE to the DCE.

Table 1: *Summary of RS-232C serial interface connections and their function.*



Figure 1: *Diagram of a typical setup that allows a terminal to communicate with a computer over standard telephone lines. The modems shown are called DCE, or data-communication equipment, while both the terminal and the computer are called DTE, or data-terminal equipment. When referring to the RS-232C serial interface, the transmit/receive designation is always defined in terms of a DTE-to-DCE connection.*

Many terminals and computer serial I/O circuits generate the request-to-send and data-terminal-ready signals and expect to receive the corresponding signals clear-to-send and data-set-ready back from the modem. If these are not turned on, the DTE will not allow itself to transmit or receive data. If you plug together two pieces of equipment, both of which are configured as DTE, their data-terminal-ready and request-to-send signals will be connected together, and neither will know how to get the required data-set-ready or clear-to-send acknowledgments. Again, the solution is to cross-connect the corresponding signals so that the DTR signal output of one device goes to the ready DSR input of the other and each unit's RTS signal goes to its own CTS input.

The clock signals listed in table 1 are rarely used. If you need them, cross-connect them. Sometimes a device will need the ring indicator from a modem before it will start accepting incoming data. This can be obtained by connecting this pin to the DTR pin of the other device.

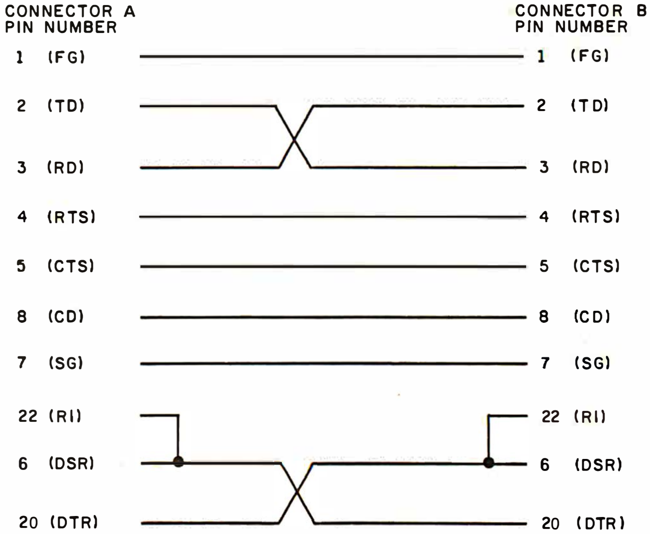


Figure 2: *The interconnection scheme for a null modem. A null modem is a "black box" that allows two pieces of data-terminal equipment to communicate with each other when a phone line is not required (such as when they are in the same room). If the two pieces of equipment were connected without the use of a null modem, both would be sending information on the same RS-232C connector pin and also would expect to receive data on the same pin.*

Construction

Figure 2 is a diagram of an interconnection scheme that works in most cases. If you need a different set of signals, it may be modified; table 1 provides the necessary information. In some cases you will need to connect a device that requires the DSR control signal to another that doesn't generate the corresponding DTR signal. In this event, connect the DSR pin of the first device to its own DTR pin.

If you buy one of the commercially produced null modems, you will probably get a box about the size of a large paperback book, with two female connectors (DB-25S sockets). I found it more convenient to use one male and one female connector, because their pin numbers are mirror images of each other. Placing them back-to-back lines up all the pins with the same number. I bolted one-inch separators between the screw holes of the two connectors to hold them in place and then wired the connections as shown in figure 2. I wrapped the whole thing in electrical tape to seal it. The result is a much smaller package than the commercial product. It can easily be attached to the end of the RS-232C cable and left there.

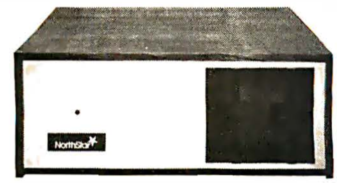
Keeping to my practice of documenting whatever I produce, I drew a diagram like figure 2 on adhesive label material and placed it on the null modem's cover. If in the future I need to know which pins are connected, I won't have to remove the covering or hunt through my files for the circuit description. It is always right there.

For Further Research

If you would like more comprehensive information on this subject, consult chapter 26 of the book *Technical Aspects of Data Communication* by John McNamara, published by Digital Press. ■

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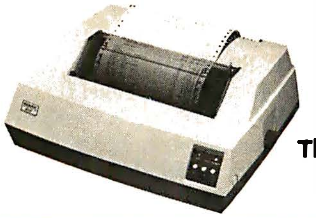
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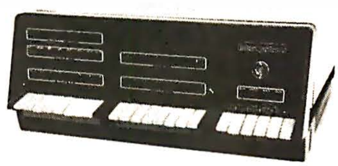


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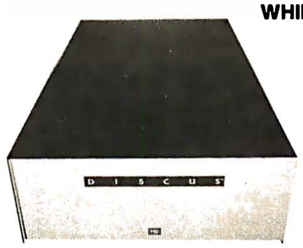
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IRV, a TRS-80 Utility Program

Teri Li, POB 481, Peterborough NH 03458

IRV is a new machine-language utility program for the BASIC programmer. It supplies features that all programmers will appreciate, and it uses less than 1 K bytes of programmable memory (unless you add to its definitions).

IRV gives you a flashing cursor, auto repeat on any key held down for more than one second, and keyboard control of the cassette remote plug (you can turn the cassette motor on and off simply by hitting *shift-clear*). [*In this review, words in italics refer to keys of the same name as those on the TRS-80 keyboard....***GW**] This is followed by the ability to define any key to your chosen definition. As sold by The Programmer's Guild, all of the shifted alphabetic keys are defined as BASIC keyword commands (see table 1); this duplicates features of the utility program called T-Short.

However, if you don't like any of the provided definitions, you can easily change them by pressing the *shift* and *down-arrow* keys, followed by the *shift* (alpha) key you want to redefine. When you have finished defining, press the *shift-down-arrow* combination once more. (Hitting *enter* merely inserts a carriage return into the definition.) This ability to redefine is not restricted to alpha keys: it extends to all of the keys on the keyboard, except for the *shift* keys and the *shift-down-arrow* key combination. This means that you can redefine both the *break* and *enter* keys!

How is this possible? Simple: IRV pokes new addresses into the keyboard Device Control Blocks used by the TRS-80. The new addresses point to IRV, which is in high memory. IRV processes each input keystroke before calling routines in read-only memory. This gives IRV its great power and versatility.

If you decide that you don't want the programmed-keys mode in operation, you can turn this feature off by hitting *shift-down-arrow* twice. To turn it back on, hit the *shift-down-arrow* twice again.

The usefulness of these definable keys is not restricted to single BASIC commands; you can actually define a key as any message, command, or series of commands up to a maximum length of 255 characters. This is true for all of the keys. If you were to exercise this option to its fullest, you would fill almost 25 K bytes of programmable memory (100 keys, uppercase and lowercase, times 255 characters per key).

Yes, one keystroke can represent a *series* of commands. Hitting *enter* inserts a carriage return but does not end the

At a Glance

Name:
IRV

Type:
BASIC utility

Manufacturer:
The Programmer's Guild
POB 66
Peterborough NH 03458

Price:
Cassette $24.95
Disk $29.95

Format:
Cassette or 5-inch floppy disk

Language:
Z80 machine language

Computer:
Radio Shack TRS-80, Model I with Level II BASIC and 16 K bytes or more of memory (disk drive optional for cassette version only)

Documentation:
5-page booklet, 14 by 22 cm (5½ by 8½ in)

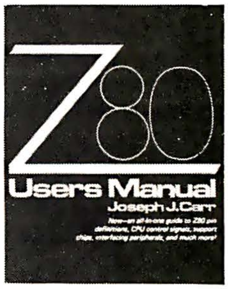
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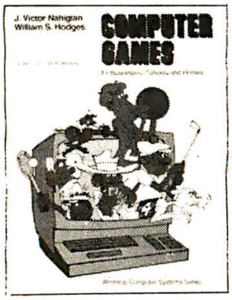
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Joseph Carr
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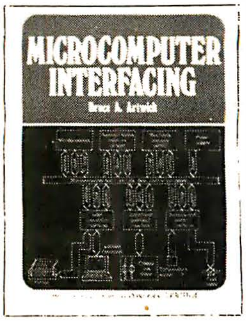
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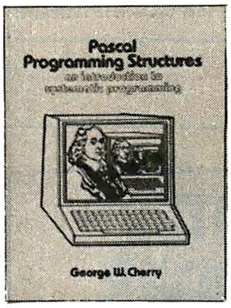
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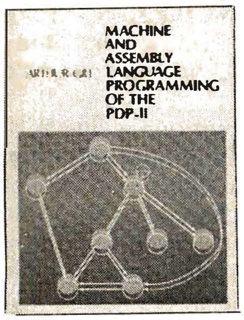
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Keystroke	Result	Keystroke	Result
shift-Q	SYSTEM (enter)	shift-G	GOTO
shift-W	RND(	shift-H	RIGHT$(
shift-E	ELSE	shift-J	INKEY$
shift-R	RETURN (enter)	shift-K	CSAVE"
shift-T	THEN	shift-L	CLOAD
shift-Y	LEN(	shift-Z	EDIT
shift-U	USING	shift-X	STR$(
shift-I	INPUT	shift-C	CHR$(
shift-O	ASC(	shift-V	VAL(
shift-P	LPRINT	shift-B	INT(
shift-A	STRING$(	shift-N	NEXT
shift-S	GOSUB	shift-M	MID$(
shift-D	DATA	shift-@	CONT (enter)
shift-F	LEFT$(	shift-right-arrow	TAB(

Table 1: *One-keystroke strings supplied with IRV. When IRV is loaded into the TRS-80, any of the single shifted keystrokes shown here will cause its associated string to be "typed" on the video display. (The word* "enter" *means that the last character typed is the same as pressing the* enter *key, thus causing the line to be executed.) These equivalencies may be changed or deleted by using the character-redefinition mode.*

definition, so you can actually define one key to execute an entire series of commands when pressed. It will do this while executing either a machine-language or a BASIC program. For example, the back-up routine in TRSDOS (call BACKUP, answer all the questions: date, password, drives used, etc) can be abbreviated to a one-keystroke command. This is convenient, especially if you are duplicating several disks.

One interesting advantage to IRV is that you can define the unshifted as well as the shifted keys. I used this feature to set up my keyboard to simulate the experimental Dvorak typewriter layout. [*The Dvorak system is a typewriter with a keyboard layout that increases speed and accuracy during touch-typing....***GW**] Other possibilities could include rearranging the keys to accommodate foreign languages that use the standard Roman alphabet, but use letters in frequencies different from English.

At this point, IRV is far superior to T-Short and other keystroke shorthand routines. But IRV does not stop here: it has even more capabilities.

IRV gives you on-screen BASIC line editing similar to the on-screen line-editing features of the Commodore PET. To use this feature, first list your program on the video, then hit the *shift-break* key combination. The blinking rate of the cursor will change slightly. Now you can use the four arrow keys to move the cursor anywhere you like on the video screen. Full-screen wraparound is supported: if the cursor leaves the screen from the bottom, it will appear at the top of the screen in the same column; leaving the screen to the right will put the cursor on the left of the same line.

Once you have put the cursor on the line in which you are interested, you may type anything you want over the line. If there are too many characters on the line, hitting the *clear* key will delete 1 character. If you need more room, each time you press the *break* key one space will be added, over which you may type. Holding down either key for more than one second causes each key to repeat its function as long as the key is depressed.

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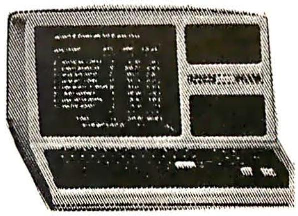
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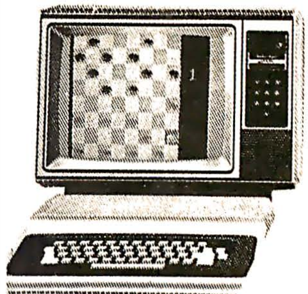
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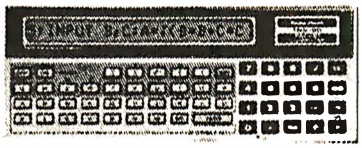
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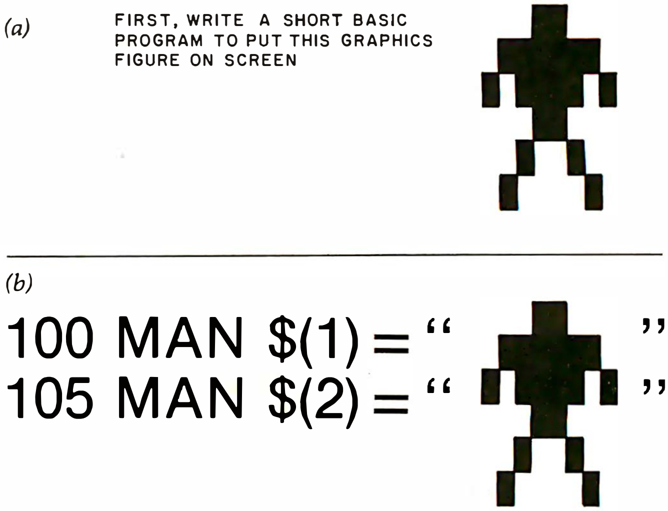


Figure 1: *Use of IRV to directly create graphics in BASIC programs. First write a short BASIC program that creates the shape you want to use. Running this program displays the shape on the video screen, as shown in figure 1a. Then use the line-editing feature of IRV to create BASIC statements (either PRINT or string-storage statements) that capture the shape, one text line at a time. In figure 1b, the shape is stored in two entries of the string array MAN$. Later, these graphic characters can be printed out in the same program using PRINT statements.*

If you are adding spaces to a line, you will notice that repeated addition of characters does not move the rightmost character down to the next line on the video display—instead, it causes the character to disappear from the screen. Likewise, if you have removed all the characters to the right of the cursor, the first character on the next line does not move up. The reason is that IRV looks only at the line on which the cursor is set.

When the line is set to your liking, hit *enter*. This transfers the changes you have made in that line to the program. If you list the line, you will be able to see that the changes have been made. Should you discover that a line is misplaced, you can use this line-editing feature to type a new number over the old line number. When you hit *enter*, the new line will be inserted into its proper place in your program, and the old line will still be in its place. This feature is handy for moving lines around in your programs.

The best advantage of the line-editing feature in IRV is that it may be invoked while in the TRS-80 edit mode. For example, it can be used to string several BASIC statements into one long multiple-statement line. Edit the line as you would normally, but when you are ready to insert, hit *shift-break*. Now position the cursor over the line that you wish to insert in the line being edited. Use the *clear* key to remove the line number (you don't want to insert a line number), then hit *enter*. List the edited line and you will see that both lines have merged: the second line is positioned where you entered the insert mode. Other uses include converting IF...THEN statements to IF...THEN...ELSE statements, or vice versa.

Still another use for the IRV line editor is to put graphics characters directly into PRINT statements. First, use a short graphics routine to draw your figure on the video display. When you've finished with the drawing, enter the IRV line-editing mode. Type a line number

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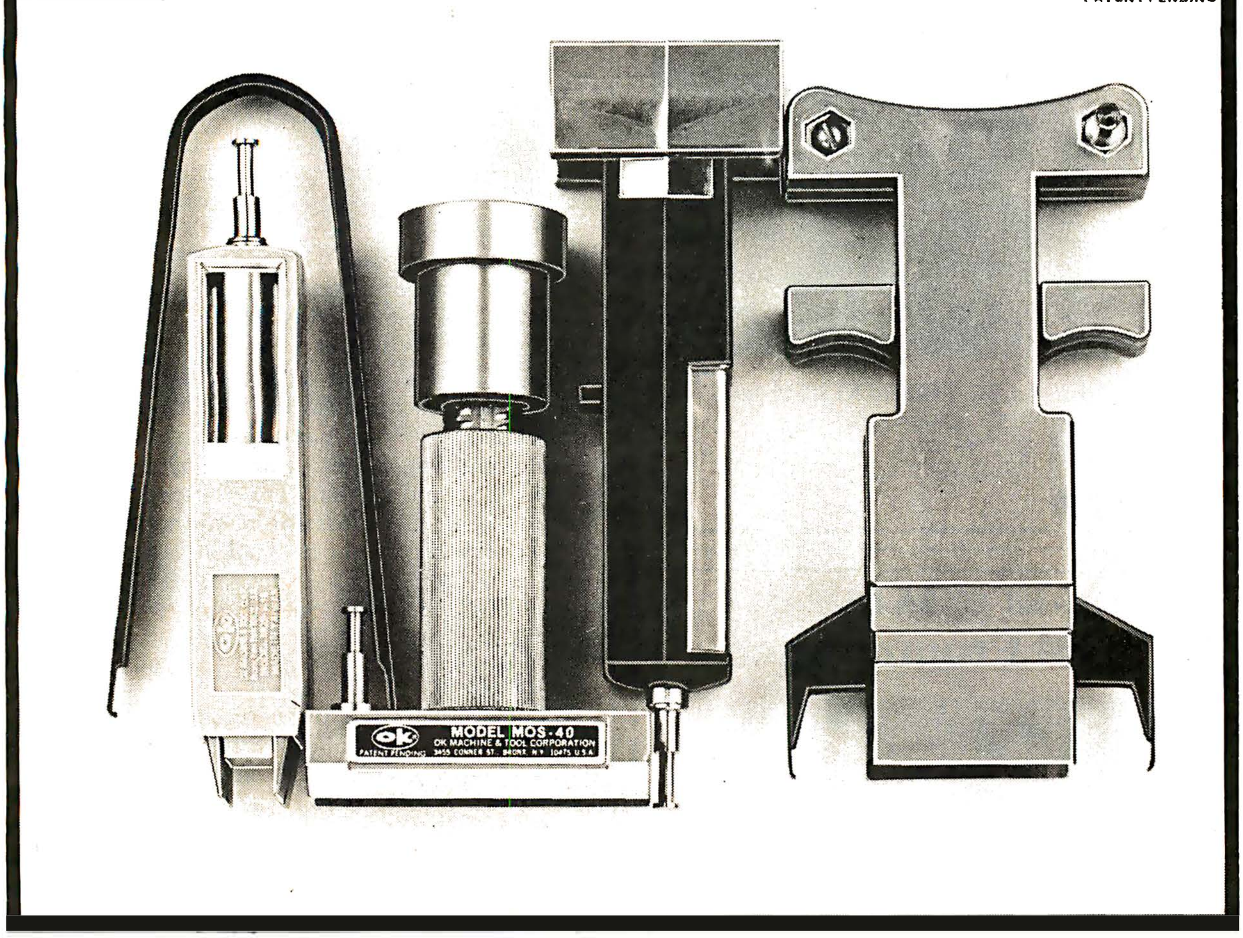
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directly onto the screen, then the word PRINT, and put quotes in front and at the end of the graphics characters. When you hit *enter*, that line will be entered into BASIC as a new line. When you list the line, you will see the graphics characters printed as BASIC keywords, but when you execute the line, the graphics figure will be drawn on the screen. You can also set the drawings equal to strings (see figure 1).

Implementation Details

IRV can be purchased in 5-inch floppy disk or cassette form. The cassette version has instructions for saving the file to disk; disk-based users may want to do this, even though the program takes exactly 17 seconds to load from cassette. Different versions of IRV are loaded (from either cassette or disk) depending on whether your TRS-80 has 16 K, 32 K, or 48 K bytes of memory. All three programs are contained on either the disk or cassette versions of IRV. You must also answer the MEMORY SIZE? prompt when entering BASIC in order to allow sufficient space for the storage of IRV and its key redefinitions. This is simple to do and is explained in the IRV booklet supplied with the software.

IRV is available from several software suppliers, including The Programmer's Guild (POB 66, Peterborough NH 03458), The Software Exchange (6 South St, Milford NH 03055), and Scott Adams' Adventure International (POB 3435, Longwood FL 32750). IRV is sold with predefined keys (see table 1) and will operate in both Level II and disk BASIC. It is compatible with TRSDOS, NEWDOS, and OS-80. For those of you with new-version Level II ROMs (or read-only memories, which power up with the abbreviated message R/S L II BASIC instead of spelling out all the words), there is also a version of IRV that will operate on your keyboards: just specify that you have the new Level II ROMs.

Conclusions

- IRV is a versatile piece of utility software for the TRS-80 Model I BASIC programmer. It allows you to redefine any keystroke as any character or series of characters, and to modify BASIC programs by simply typing over a listing of the program.
- IRV can be used to renumber BASIC lines or to merge several lines or parts of lines without having to retype the lines involved. This is a valuable aid when modifying an existing program.
- IRV can be used to turn the cassette motor on and off without repeatedly plugging and unplugging the remote motor-control plug; this is a great help when trying to work with cassette tapes.
- IRV gives every key an auto-repeat facility.

[**Editor's note:** *IRV is one of the most exciting pieces of software I've seen in a long time, primarily because it allows you to devise uses for it that are not specifically planned by the software designers. For example, when editing a line of BASIC code, you can use a single key that is defined as ten copies of the string "S D" (each of which will search for a blank and delete it) to take all of the spaces out of a line: this speeds up the task at hand by eliminating dozens of keystrokes. Because of its open-ended design, IRV can be used in a variety of situations, and I feel that it is as important and innovative as the popular VisiCalc program. Philip Mork, the author of IRV, is to be commended for his fine work...GW*]■

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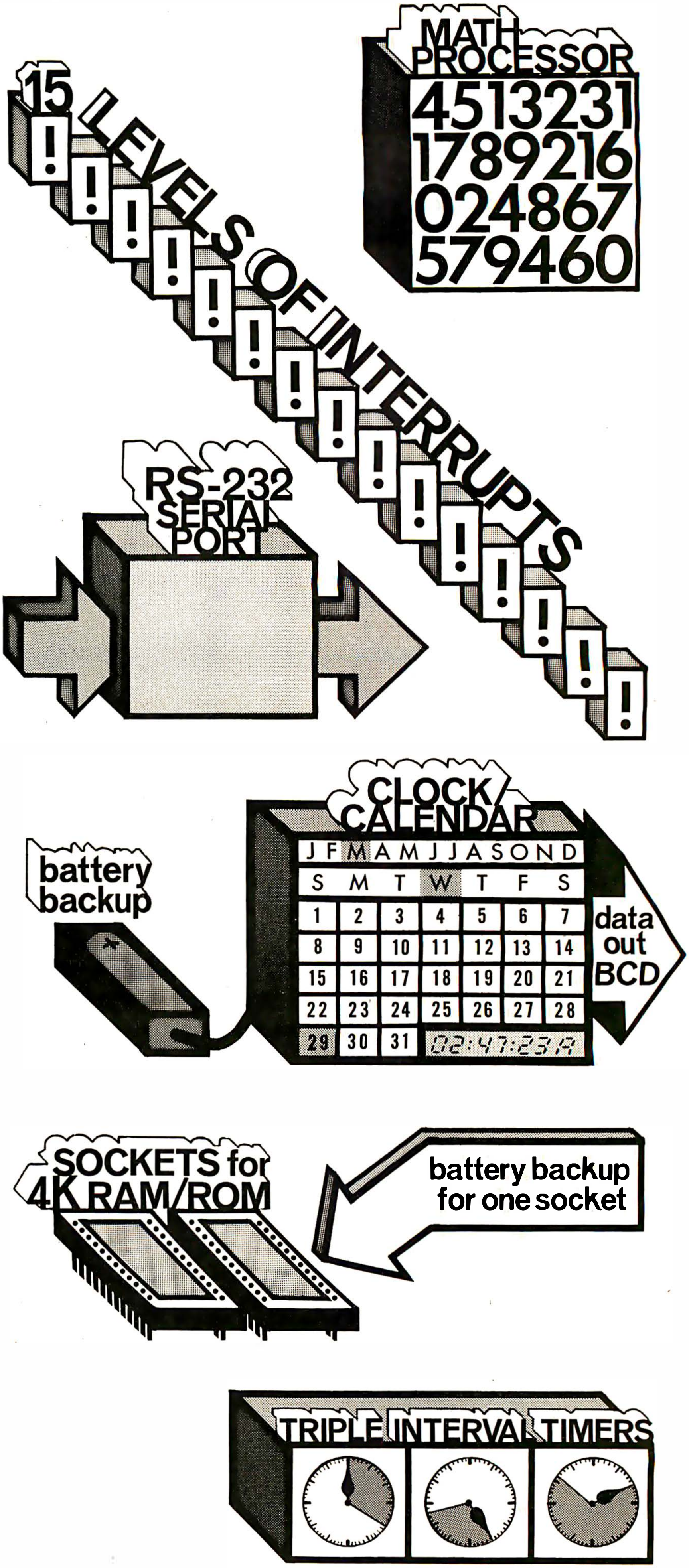
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News And Speculation About Personal Computing

Conducted by Sol Libes

UNIX Standard Called For: "/usr/group" is a newly formed group for users of UNIX and UNIX-like operating systems. At a recent group meeting, a Western Electric representative disclosed that his company has granted approximately 156 commercial licenses at about 244 commercial sites. Many present at the meeting complained about Western Electric's excessive charges for unsupported software. The company typically charges $12,000 for a single processor license and as much as $40,000 for users of the DEC (Digital Equipment Corporation) VAX machines.

UNIX users, now faced with many different implementations of UNIX, are beginning to be concerned with standards. To help cope with the problem the group plans to issue a *UNIX Users Guide.*

Also at the meeting, Microsoft announced plans for implementations of its Xenix package on the Texas Instruments TI9900, IBM Series/1, and Point 4 Data Corporation systems.

For more information write, /usr/group, POB 8570, Stanford CA 94305.

UCSD Pascal 4.0 To Be Released: A new version of UCSD Pascal will soon be released by Softech MicroSystems. The good news is that Pascal 4.0 will have many new features, such as multitasking and better screen handling. In other words, it will be more flexible, do more jobs, and be generally more powerful.

The bad news is that it will generate code that includes four new p-code instructions. Hence, the Pascal MicroEngine, presently the fastest available Pascal system, will not be compatible with the new 4.0 version. Of course, WD (Western Digital) can recode the MicroEngine microcode ROMs (read-only memories) to include the new instructions, but I don't know. Considering that it took WD nearly a year to come out with the present ROM set, I do not foresee the possibility of MicroEngine Pascal 4.0 for some time yet.

Voice Entry System For The Apple: Scott Instruments, Denton, Texas, will introduce an Apple version of its voice entry system. To be called "Applevet," this system will be able to recognize as many as 680 words or utterances. An $895 price tag for the system will include a plug-in board, a noise-canceling microphone, and demonstration disk.

Voice-Operated Telephone Dialer Tested: Bell Labs, Murray Hill, New Jersey, has disclosed that it is testing a telephone dialer that is voice operated. The caller can ask for a 4-digit telephone extension or a name in the directory of the system, and the system will then dial the number. The dialer has already demonstrated a high reliability. If in doubt as to what it is told, it asks the caller to repeat the entry.

The system uses a high-speed array processor attached to a minicomputer to detect the presence of speech and identify voice features to be used by a word recognizer. The word recognizer compares the features of the utterance to a subset of stored features and generates a word-candidate list, which is ordered according to the probability of the word's occurrence. The system uses a feature template of the caller's voice, learned during a training period, to recognize the caller's voice input and dial the number. The system recognizes only isolated word inputs, and the user must speak slowly and haltingly.

Where Are The 64 K-Bit Memory ICs? At one time, memory size quadrupled every two years. But four years have now elapsed between the introduction of the 16 K-bit and the 64 K-bit memory ICs. Skyrocketing development costs and difficulties in working with such dense devices have caused most of the delay. It is likely that the next quadrupling will take even longer.

Over two dozen suppliers are now delivering samples of 64 K-bit programmable memories to computer manufacturers; some of the samples are already in limited production. You can expect to see the first products using 64 K-bit integrated circuits in the third or fourth quarter of this year. However, do not look for their widespread use until sometime in late 1982 or 1983, when prices should drop to under $10 each.

American memory manufacturers are extremely concerned about Japanese competition in this area, however. The first company to supply 64 K-bit circuits was Fujitsu Ltd, and eight other Japanese manufacturers are jumping in too. Some manufacturers fear that the Japanese may snare 60% to 70% of the 64 K-bit memory market. If this occurs, the entire American computer industry may find itself in trouble.

Apple Stock Goes On Sale: Shares in Apple Computer Inc, one of the most eagerly awaited public stock offerings, went on sale early in December 1980. Apple offered 8% of the company's 52.4 million shares (ie: 4.6 million shares) at a price of $22 per share.

Apple, incorporated in 1977, reported profits of $11.7 million on sales of $117 million for the fiscal year ending September 26, 1980. 1979's earnings were $5 million on $48 million sales, and, in 1978, sales were $7.8 million with profits of $793,497.

Steve Jobs, 25 years old, and Steve Wozniak, 30 years old, the creators of the Apple computer, each hold 8.3 million shares. That means that they own well over $100 million worth of stock. A C Markkula, 32 years old, who took Apple from a garage operation to its current enviable position, also holds 8.3 million shares. Venrock Associates, a venture capital firm, holds 3.8 million shares. Significant blocks are held by several other venture capital concerns. Xerox holds 80,000 shares.

Status Report On The IAPX-432: Late last spring, Intel announced its iPAX-432 32-bit microprocessor with great fanfare. At that time, only very general specifications were released and subsequently reported on in this column. (See "Intel Releases Data On 32-Bit Microproces-

sor," August 1980 BYTE, page 94.) During the fall, however, Intel made large-scale presentations to several major systems-level houses. Rumor has it that Intel will deliver a paper at the International Solid State Circuit Conference (ISSCC) this month, in which it will divulge full details on the architectural design of the iAPX-32. Intel should start delivering samples within another month or two.

The iAPX-32 is a 3-chip set that uses more than 100,000 transistors per IC (all 64-pin packages). The design of the instruction set is aimed at supporting high-level compiled programs written in Pascal, Ada, and FORTRAN.

Intel had also let it be known that it planned to supply microcoded firmware in the processor device that would directly execute the Ada high-level language. However, rumor currently has it that Intel is retreating from this concept.

Status Report On 16-Bit Microcomputers: The 16-bit scene matured during 1980. Intel sold about 200,000 of its 8086 devices (at well over $100 apiece, Intel appears already to be profiting from this unit). By midyear, Zilog had managed to remove the bugs from the Z8000 and, by year's end, was in full production. Motorola must be given credit for designing the most powerful 16-bit microprocessor (imagine having seventeen 32-bit-wide registers and 23-bit addressing to reach 16 megabytes of memory directly). It must be considered a landmark achievement that Motorola was actually shipping limited production quantities of fully functional 68000 devices by the end of 1980 that met specifications. This is particularly impressive when you consider the number of elements in the device (about 70,000) and the large size of the silicon chip (246 by 280 mils).

In production now for two years, the 8086 is just beginning to develop a respectable software base. For example, Digital Research is starting to supply an 8086 version of CP/M. The software bases for the Z8000 and 68000 are still extremely limited and are probably more than a year behind the 8086 software base.

National Semiconductor expects to start shipping samples of its new 16032 16-bit chip set, which promises features similar to the DEC (Digital Equipment Corporation) 32-bit VAX machines. The silicon area on this device (250 by 300 mils) is even larger than Motorola's 68000. Industry observers concede that this set of devices is significantly more powerful than the 68000, the Z8000, or the 8086. However, many observers doubt whether National will be able to compete with Intel, Zilog, and Motorola, because of its late start and the great expense of such a project.

Soviets Develop 8080A-Like Microprocessor: According to a technical report released by CDC (Control Data Corporation), the Soviet Union is manufacturing a microprocessor that is very similar to Intel's 8080A design. Control Data obtained samples of the integrated circuit from the Hungarian government, and promptly dissected it. They discovered that the device, called the K80IK80.77, uses the same circuit blocks as the 8080A, except that it is adapted for the NMOS (n-channel metal-oxide semiconductor) process.

In the manufacturing process, Soviet technicians relaxed line widths and geometry separations and used a larger chip size (214 by 192 mils, compared to 193 by 171 mils for Intel, which Intel later reduced to 165 by 161 mils). The Soviet design is thus more conservative and more expensive to produce. CDC identified several "workmanship flaws" in the devices (eg: questionable die attachments and scraping of bond wires). CDC felt that the Soviet technology was equal to American technology, vintage 1977. The device uses a 48-pin package with eight unused pins.

Home-Banking/Information System Inaugurated: Radio Shack, CompuServe, and United American Service Corporation have joined forces to inaugurate a nationwide home-banking and information system. (See "You Can Bank on It," January 1981 BYTE, page 10.) Using the new TRS-80 Color Computer, a television receiver, and a modem, a subscriber will be able to pay bills, obtain a bank statement, do bookkeeping, apply for a loan, send and receive electronic mail, and access the CompuServe data base. The service will cost between $15 and $25 a month. United American expects to have forty banks and 20,000 subscribers in the system by the end of the year.

Digital Research To Introduce Record-Retrieval System: Digital Research (DR) will soon introduce a record-keeping software package called BT-80. Basically, it is the kernel for a data-base management system. DR has also indicated that it is "taking a hard look at possibly implementing CP/M, MP/M, and PL/I on 68000 and Z8000 systems." Further, they have purchased a Digital Equipment Corporation VAX machine. Although this machine is primarily intended to keep track of their internal operations, it will be using the UNIX operating system. Does this mean that DR might be taking a close look at UNIX? After all, several DR staffers have strong UNIX backgrounds.

Digital Research has also disclosed that it is considering the possibility of developing a software interface between CP/NET and the EtherNet systems.

The Microprocessor Catch-22: Intel is currently the only supplier of the 8088 microprocessor (which is actually a 16-bit 8086 with 8-bit input and output). Most designers tend to avoid a part that is not "second-sourced." In other words, they want to be able to get the part from another source if their primary source has delivery problems. Mostek has said that it is interested in second-sourcing the 8088 if demand warrants. My question is, how is the demand to materialize while waiting for a second-source to enter the marketplace?

Random Bits And Random Rumors: The EtherNet's specifications have been finalized and published. If you would like a copy, contact the EtherNet Literature department at either Xerox, Intel, or Digital Equipment Corporation.... NEC is about to introduce a low-cost version of its Spinwriter word-processing printer. This new machine will sell for $1400 (in lots of 100) and it will also be used with a new NEC microcomputer system rumored for introduction later this year.... It is being whispered that Epson America Inc, Torrance, California, will soon unveil a low-cost daisy-wheel printer.... Ontrax Corporation, Sunnyvale, California, plans to introduce a 116-megabyte 8-inch Winchester disk drive soon.... Before long, General Instrument will place on the market a speech-synthesis chip set in the $5 price range for large volumes. The set will include the controller, 32 K bytes or 128 K bytes of ROM and speech modules....

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Hewlett-Packard is about to set forth a single-board microprocessor version of its 1000-L computer to compete with the Digital Equipment Corporation LSI-11.... Control Data plans to introduce a self-contained PLATO system. The PLATO system is currently a mainframe-based system that includes remote terminals with high-resolution graphics and an extensive library of interactive educational software.... Shugart Associates, the current leader in floppy-disk drives, is rumored to be developing an optical disk-storage system. The basic technology for this system was developed by Shugart's parent organization, Xerox, and Thompson-CSF....

First Xenix/Z8001 System Announced: Tri-Data Systems, City of Industry, California, is the first company to announce a microcomputer system using the Zilog Z8001 and Microsoft's Xenix operating system. The Z8001 employs segmented rather than direct addressing. This desk-top system, called the SST, contains a Z8010 memory-management integrated circuit that dynamically relocates code and protects memory areas. The SST utilizes a ten-slot motherboard for memory expansion in 128 K-byte modules.

Will Microcomputers Leapfrog Over Minicomputers and Mainframes? The newer 16- and 32-bit microprocessors, soon to be sampled by integrated-circuit manufacturers, will contain some new and sophisticated features. For example, the forthcoming NS16000 16-bit microprocessor from National Semiconductor and the iAPX-432 microcomputer from Intel will both have true virtual memory capability that will allow very large memory systems. Sixteen-bit microcomputers like the 8086, Z8000, and 68000 do not lend themselves to virtual memory systems. Intel, however, says that it expects to have an 8086 with virtual memory later this year.

Virtual memory requires the microprocessor to stop in the middle of an instruction if it determines that the address called is not in memory, back up execution of the instruction, and restart the instruction after the contents of that virtual address have been brought in from a mass-storage device (eg: a hard disk).

Returning to the original question, experts concede that, simply because microcomputers now have features once found only in larger machines, it does not follow that they will overtake minicomputers and maxicomputers. Each year the minicomputers and maxicomputers add performance features that keep their power far ahead of microcomputers. In fact, the new more powerful microcomputers now have features that were found in larger systems five or more years ago.

Robot Kit Announced: In the December 1979 BYTE News, I predicted that a robot kit would be introduced in 1980. It now seems as if that prediction will come true in 1982. Heath Company recently demonstrated a 3-foot-high robot prototype to Heath retailers that it plans to introduce in 1982. The robot kit will use the Motorola 6802 microprocessor with 4 K bytes of programmable memory and 32 K bytes of ROM (read-only memory). It will have a detachable joystick, voice synthesis, and one multipurpose arm. At this time, it is projected that the kit will cost less than $1000.

Change Of Name: *Seagate Technology* is the new name for Shugart Technology. Seagate Technology is the Scotts Valley, California, firm that manufactures Winchester-technology 5¼-inch hard-disk drives. The decision to change its name was made by Seagate Technology to help distinguish it from the famous maker of floppy-disk drives, Shugart Associates. Both companies were founded by David Shugart. However, Mr Shugart is no longer affiliated with Shugart Associates.

MAIL: I receive a large number of letters each month as a result of this column. If you wish a response, please include a stamped, self-addressed envelope.

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(5) MAIL LIST MERGE...An add on package that allows the user to send form letters (created on WORD-STAR) to any compiled mailing list (using any CP/M based MAIL program such as the PEACHTREE MAIL PROGRAM)...requires CP/M, WORD STAR and andy CP/M based mail program...$150.

(6) SELECTOR III (Micro-Ap)...complete data management system...user defined fields and codes...manages any list defined by the user...includes additional modules for simplified inventory control, accounts receivable and accounts payable...requires CBASIC-2...$295.

(7) SELECTOR IV (Micro-Ap)...the ultimate data management system...all features use the **SELECTOR III** plus...data file format conversions...full page report formatter...computations...global search and replace...hard disk compatible...data/text merging...$550.

(8) GLECTOR (Micro-Ap)...add on package to the **SELECTOR**...general ledger that allows the user to define a customized chart of accounts...$350.

(9) CBASIC-2...a non-interactive BASIC used for many programs that run under **CP/M**...allows user to make more efficient use of disk files...eliminates the use of most line number references...require on such programs as the **SELECTOR**...$120.

(10) MICROSOFT BASIC...an enhanced version of the **MICROSOFT BASIC** found on **TRSDOS**...adds commands such as chaining (allows the user to LOAD and RUN a new program without losing the variables currently in memory)...long variable length file records, WHILE/WEND and others...can be used with the BASIC COMPILER to speed up programs (3-10 times faster execution)...$325.

(11) MASTER TAX (CPAids)...professional tax preparation program...prepares schedules, A, B, C, D, E, F, G, R/RP, SE, TC, ES and forms 2106, 2119, 2210, 3468, 3903, 2441, 4625, 4726, 4797, 4972, 5695 and 6521. Printing can be on readily available pre-printed continuous forms, on overlays, or on computer generated IRS approved forms. Maintains clint history files...interactive with CP/Aids General Ledger...$995.

(12) GENERAL LEDGER II (CPAids)...designed for CPA's...stores complete 12 month detailed history of transactions...generates financial statements, depreciation, loan amortizations, journals, trial balances, statements of changes in financial position, and compilation letters...includes payroll system with automating posting to general ledgers...prints payroll register, W2's and payroll checks...$450.

(13) ELECTRIC PENCIL (Michael Shrayer Software)...Complete word processor with extensive editing and printer formatting features...$275 (Standard printer version)...$300 (DIABLO, NEC or QUME version).

(14) BASIC COMPILER (Microsoft)...changes your source programs into machine language...increases program execution by 3-10 times...$395.

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Image Processing With a Printer

Clark A Calkins
2564 Walnut Blvd #106
Walnut Creek CA 94598

For a long time I have been interested in producing recognizable images using a basic Teletype just as you see in many computer stores; and I thought that an expensive camera and interface were required to digitize the picture. But in 1979 an article in *Dr Dobb's Journal* described just how to do this type of image processing with a Diablo printer. (See reference 1.) While I didn't have this type of printer, I figured the concept should work with my Model 43 Teletype or any other printer. After all, the hardware interface required looked simple enough. What could I lose? I worked out my ideas, implemented the system, and now I can process images inexpensively at home. So as a successful personal-computer experimenter, I'll pass on my experience to you.

An Overview of the System

The principle behind this image processing system is easy to understand and implement in a home computer system. The procedure used to prepare a digital picture contains the following steps:

- Connect a light-sensitive device (such as a phototransistor) to the input of an A/D (analog-to-digital) converter that is connected to the computer.
- Mount the phototransistor on the print head of the printer so that it senses light reflected off the paper in the printer's print position.
- Place the paper containing the image in the printer so the print head will traverse the image; then send a series of space characters to the printer to cause the print head to move across the paper.
- Measure and store the values of light intensity at each character position under program control, using A/D-converter output.
- Insert a blank sheet of paper into the printer.
- Use a computer program to print selected characters onto the blank sheet; each character corresponds to the light intensity at a given print position. The higher the intensity, the lighter the character should be.

Having decided that this would be an interesting project, I went to the local electronics store and purchased the necessary parts and assembled the unit. When I loaded in a sample control program written in BASIC, the thing actually worked, and after a little experimentation, I could even recognize some features! Then the fun started, I cut pictures from the magazines lying around the house and started to process them while trying different substitution characters. This was great fun for my entire family!

After a few hours of playing with this system, I started to realize that I needed a better control program that would execute faster. The BASIC program worked at about three characters per second, but with a faster program, I could try larger pictures. The basic functions required were:

- Scan over a variable-width image of any reasonable length at a much faster speed.
- Save the resulting digital data out on a disk file for later use.
- Be able to use a user-defined character-substitution sequence (the more flexible, the better).

The results of this effort are shown in listing 1. Here is a control program written for the CP/M (version 1.4) operating system that does what is required (and a little more). It can scan a line of up to 255 characters and as many as 255 lines (memory permitting). The character-substitution sequence is limited to sixty-four char-

About the Author
Clark A Calkins has worked for 11 years with the General Electric Company at the Vallecitos Nuclear Research Center and now holds a position as a systems programmer for the Advanced Nuclear Applications Group.

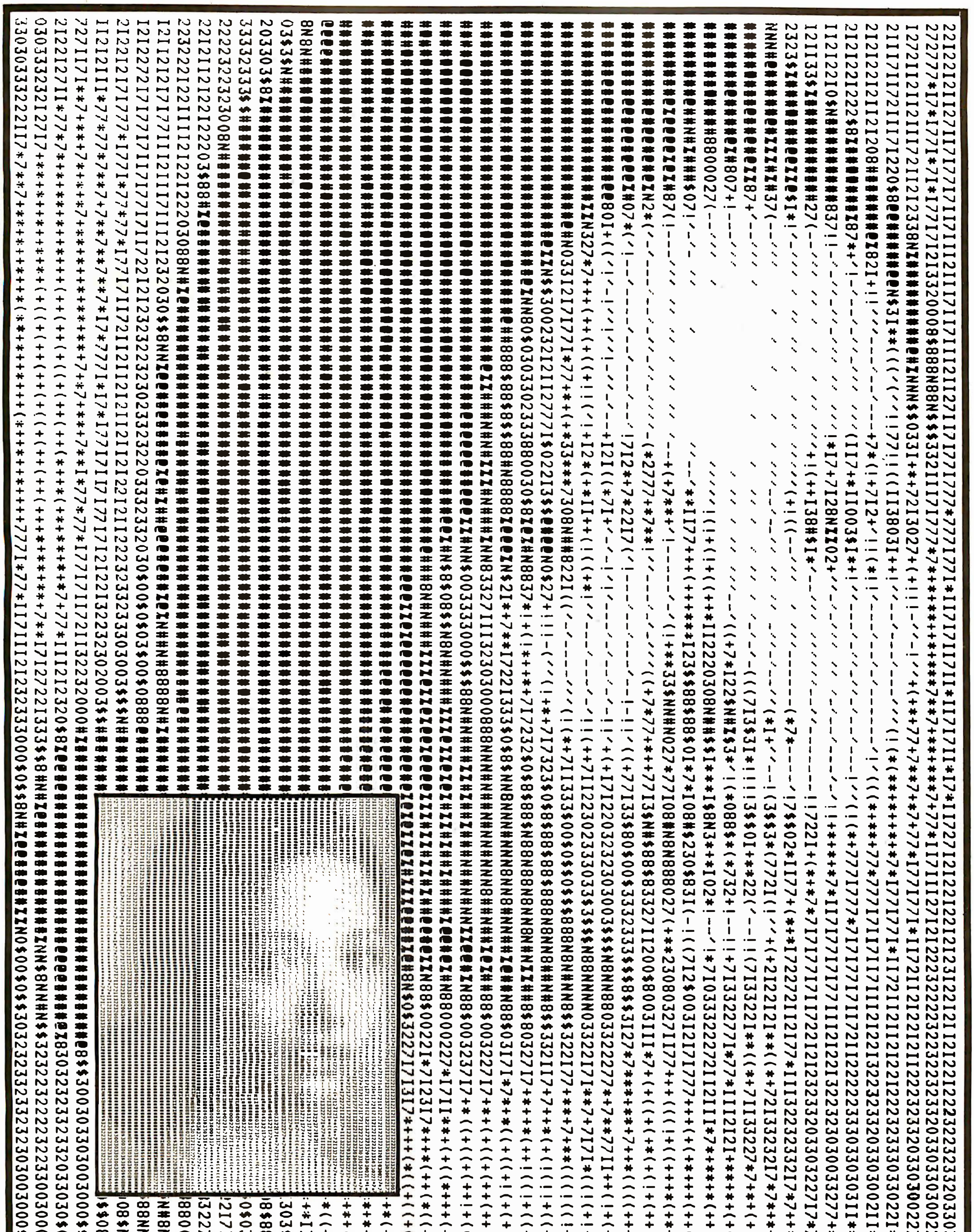


Figure 1: *The image reproduced by IMAGE was originally a black-and-white photograph. The analog-to-digital converter used by the author registered a dark-to-light difference of 130, when the picture was processed. Magazine and book photos or artwork can also be reproduced satisfactorily.*

F = file the data.
H = help, display menu.
M = set maximum and minimum values.
P = print the data back out.
Q = quit and return to CP/M.
R = read the file in.
S = scan a new page.
T = set the tone array.

Table 1: *The menu displayed by IMAGE.*

acters, and there is a primary and secondary string. Two separate strings were chosen so the printer would not have to backspace to provide overstrike capability; characters from the secondary string print on top of those from the primary string. However, it does have to return the carriage without feeding a line.

For an example of what a user can do with this system, refer to figure 1. In order to achieve the desired contrast, it was necessary to use overstrike on the darker areas. This picture originally was a black-and-white photograph reproduced from a magazine page. The difference between the maximum and minimum values read from the A/D converter for this picture was decimal 130. The higher this difference is, the more contrast the resulting printout will have and the better it will look.

Using IMAGE

The image processing program, IMAGE, is run as a transient program under Digital Research's CP/M operating system. If IMAGE is being used under some other system, the start-up procedure would change. The program is initially executed by typing in the following command line:

A>IMAGE filename

In this case, the data-storage file is identified as "filename.img". (The extension "img" is assumed by the program.) This will be used for all correspondence with the disk. When control is transferred to this program, a heading and initial menu are displayed, allowing the user to choose one of several options. (See table 1.) The user may type either F, H, M, P, Q, R, S, or T (uppercase or lowercase). Anything else is ignored and causes the full list to be printed.

F: File the Data

This writes out the data that was

Text continued on page 240

Listing 1: *IMAGE, the control program for image processing. This version is written for CP/M version 1.4 (compatible with version 2.0) and can scan 255 lines of up to 255 characters. Overstrike capability is provided to increase contrast of output pictures by darkening areas as necessary. Try squinting your eyes or holding the images at different viewing distances to obtain a maximum of picture clarity (ie: the illusion's gestalt).*

```
                    ;  IMAGE.ASM                         NOVEMBER 4,1979
                    ;
                    ;  COPYRIGHT 1979, CLARK A. CALKINS
                    ;
                    ;
                    ;  THIS PROGRAM ALLOWES A USER TO SCAN OVER AN IMAGE PLACED IN
                    ; THE CP/M LIST DEVICE AND RECORD THE RELATIVE GRAPHIC DENSITY
                    ; VIA AN A/D. IT IS ASSUMED THAT THE USER HAS PLACED A PHOTO
                    ; SENSITIVE DEVICE ON THE HEAD OF THE PRINTER AND CAN READ
                    ; THE RELATIVE ENTENSITY OVER AN A/D CHANNEL. REFER TO DR.
                    ; DOBBS JOURNAL, OCTOBER 1979 (VOL 4, ISSUE 9, #39) FOR DETAILS
                    ; ON DOING THIS.
                    ;
                    ;  TO USE THIS PROGRAM, TYPE:
                    ;  A>IMAGE FILENAME<RET>
                    ;
                    ;  ONCE EXECUTING, THIS PROGRAM WILL ASK FOR THE OPTION THAT
                    ; IS DESIRED. THE USER MAY;
                    ;
                    ;  1) SCAN A NEW IMAGE AND RECORD THE DENSITY DATA,
                    ;  2) FILE THE EXISTING DATA AWAY ON THE FILE SPECIFIED,
                    ;  3) READ IN DATA FROM A PREVIOUSLY SAVED SCAN FROM THE
                    ;     SPECIFIED FILE,
                    ;  4) SET THE TONE ARRAYS THAT WILL BE USED TO PRINT BACK THE
                    ;     IMAGE TO ANY DESIRED SET OF CHARACTERS,
                    ;  5) PRINT OUT THE IMAGE USING THE CURRENT TONE ARRAYS,
                    ;  6) SET MAXIMUM AND MINIMUM VALUES.
                    ;
                    ;  THE FILE NAME SPECIFIED WILL BE GIVEN THE DEFAULT EXTENSION
                    ; OF 'IMG'AND THIS MUST EXIST IF DATA IS TO BE READ BACK IN, OR
                    ; IT WILL BE CREATED (IF NECESSARY) IF NEW DATA IS TO BE FILED
                    ; AWAY. TO SCAN A NEW IMAGE, THIS CODE WILL ASK FOR THE DESIRED
                    ; LINE LENGTH. TYPE IN THE LENGTH (IN DECIMAL) AND THEN YOU WILL
                    ; BE GIVEN THE OPPORTUNITY TO POSITION THE PAPER BEFORE THE SCAN
                    ; STARTS. ONCE STARTED, THE SCAN WILL CONTINUE UNTIL 255 LINES
                    ; HAVE BEEN SCANNED OR THE USER HAS TYPE ANY KEY (ONLY CHECKED
                    ; AT THE END OF A LINE). THE RANGE OF VALUES READ WILL BE GIVEN
                    ; AND CONTROL WILL RETURN TO THE OPTION SELECTION LEVEL. WHEN
                    ; PRINTING THE DATA BACK OUT, TYPING ANY KEY (AGAIN AT THE END
                    ; OF A LINE) WILL HALT THE PROCESS AND RETURN TO THE OPTION
                    ; SELECTION LEVEL.
                    ;
                    ;  THIS PROGRAM WILL NOT CHECK MEMORY USAGE, SO BE SURE THAT
                    ; THERE IS ENOUGH ROOM FOR THE IMAGE BEING SCANNED (ONE BYTE
                    ; IS USED PER COLUMN POSITION, PER LINE.
                    ;
                    ;
                    ;
                    ;
0100                        ORG     100H
0100 31D307         IMAGE   LXI     SP,STACK        ;SETUP STACK
0103 117C04                 LXI     D,HELLO
0106 0E09                   MVI     C,9
0108 CD0500                 CALL    CPM
010B 216500                 LXI     H,005CH+9 ;SET IMAGE EXTENSION TO 'IMG'.
010E 3649                   MVI     M,'I'
0110 23                     INX     H
0111 364D                   MVI     M,'M'
0113 23                     INX     H
0114 3647                   MVI     M,'G'
                    ;
                    ;  ASK FOR THE DESIRED OPTION. HERE WE DON'T WAIT FOR A CARRIAGE
                    ; RETURN, JUST THE FIRST THING TYPED. INVALID RESPONCES ARE
                    ; IGNORED.
                    ;
0116 11B504         OPT     LXI     D,OPTION;WHAT DOES THE USER WANT TO DO?
0119 0E09                   MVI     C,9
011B CD0500                 CALL    CPM
011E 118105         WHAT    LXI     D,QUESTN
0121 CDF303                 CALL    ASK
0124 E65F                   ANI     5FH     ;MAKE UPPER CASE FOR COMPARISONS.
0126 FE46                   CPI     'F'     ;FILE THE DATA?
```

Listing 1 continued on page 224

Qantex IMPACT PRINTERS

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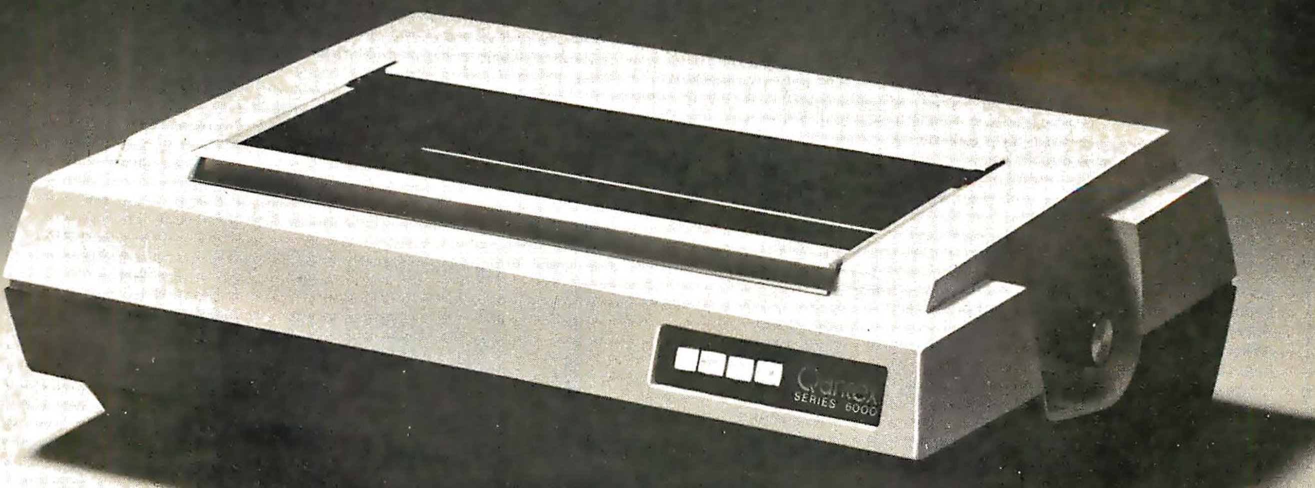
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Introducing

Listing 1 continued:

```
0128 CAA302            JZ     FILE
012B FE50              CPI    'P'       ;PRINT THE FILE
012D CA0502            JZ     PRT
0130 FE54              CPI    'T'       ;SET THE TONES
0132 CA5A03            JZ     TSET
0135 FE53              CPI    'S'       ;SCAN A NEW PAGE
0137 CA4C01            JZ     SCAN
013A FE51              CPI    'Q'       ;QUIT PROCESSING
013C CA0000            JZ     0
013F FE52              CPI    'R'       ;READ IN THE FILE?
0141 CA0F03            JZ     READF
0144 FE4D              CPI    'M'       ;SET MAX AND MINS
0146 CA7D03            JZ     SETMAX
0149 C31601            JMP    OPT       ;NOT RECOGNIZED
                 ;
                 ;
                 ;  SCAN ACROSS THE PAGE AND COLLECT DATA FROM THE A/D. AT FIRST
                 ; ASK THE USER FOR THE LINE LENGTH TO USE (A DECIMAL NUMBER).
                 ; THEN GIVE HIM/HER AN OPORTUNITY TO POSITION THE PAGE BEFORE
                 ; STARTING. CONTINUE SCANNING UNTIL 255 LINES HAVE BEEN CHECKED
                 ; OR THE USER HAS TYPED A KEY (CHECKED AT THE END OF A LINE
                 ; ONLY). WHEN DONE, REPORT THE MAXIMUM AND MINIMUM VALUES READ
                 ; FROM THE A/D. WE HOPE THAT THE USER HAS ENOUGH MEMORY FOR ALL
                 ; OF THIS SCAN DATA (ONE BYTE PER COLUMN PER LINE) AS A CHECK
                 ; IS NOT MADE (BUT COULD BE IN NECESSARY).
                 ;
014C AF          SCAN  XRA    A
014D 32D307            STA    MAX       ;SET MAXIMUM AND MINIMUM VALUES
0150 3D                DCR    A
0151 32D407            STA    MIN
0154 111D06            LXI    D,LLNGTH          ;FIND LINE LENGTH FROM USER
0157 0E09              MVI    C,9
0159 CD0500            CALL   CPM
015C CD9C03            CALL   GETNUM    ;GET NUMBER FROM USER.
015F 32D507            STA    LNGTH
0162 1E0D              MVI    E,13      ;RETURN THE CARRIAGE
0164 CD0A04            CALL   PRINT
0167 119F05            LXI    D,POS     ;TELL USER TO READY THE PAPER
016A CDF303            CALL   ASK
016D 1604              MVI    D,4       ;THIS IS A SECTOR COUNTER
016F 3E01              MVI    A,1
0171 320807            STA    NSECT
0174 0EFF              MVI    C,255     ;MAXIMUM ROW COUNT
0176 21D707            LXI    H,BUFF    ;SET BUFFER ADDRESS
0179 3AD507      OUTLP LDA    LNGTH     ;COLUMMN COUNT
017C 47                MOV    B,A
017D CDCF03      INLP  CALL   READ      ;GET A VALUE FROM THE A/D
0180 77                MOV    M,A
0181 3AD307            LDA    MAX       ;KEEP TRACK OF MAX AND MIN VALUES
0184 BE                CMP    M
0185 D28C01            JNC    D01
0188 7E                MOV    A,M
0189 32D307            STA    MAX
018C 3AD407      D01   LDA    MIN
018F BE                CMP    M
0190 DA9701            JC     D02
0193 7E                MOV    A,M
0194 32D407            STA    MIN
0197 23          D02   INX    H
0198 14                INR    D         ;COUNT BYTES
0199 F2A501            JP     D03       ;SECTOR LIMIT YET?
019C 3A0807            LDA    NSECT     ;YES, COUNT THEM
019F 3C                INR    A
01A0 320807            STA    NSECT
01A3 1600              MVI    D,0
01A5 1E20        D03   MVI    E,' '     ;MOVE ONE COLUMN
01A7 CD0A04            CALL   PRINT
01AA 05                DCR    B
01AB C27D01            JNZ    INLP
01AE 1E0D              MVI    E,13      ;NEXT LINE
01B0 CD0A04            CALL   PRINT
01B3 1E0A              MVI    E,10
01B5 CD0A04            CALL   PRINT
01B8 CDFD03            CALL   CHECK     ;CHECK THE KEYBOARD
01BB DACF01            JC     TOUT
01BE D5                PUSH   D
```

Listing 1 continued on page 226

Listing 1 continued:

```
01BF 110000           LXI    D,0      ;DELAY TO ALLOW RETURN OF CARRIAGE
01C2 1B       DELAY   DCX    D
01C3 E3               XTHL
01C4 E3               XTHL
01C5 7B               MOV    A,E
01C6 B2               ORA    D
01C7 C2C201           JNZ    DELAY
01CA D1               POP    D
01CB 0D               DCR    C        ;DONE WITH PAGE?
01CC C27901           JNZ    OUTLP
01CF 3EFF     TOUT    MVI    A,255    ;COMPUTE NUMBER OF LINES USED
01D1 91               SUB    C
01D2 32D607           STA    LINES
01D5 0C               INR    C
01D6 0D               DCR    C
01D7 0E01             MVI    C,1      ;RETRIEVE CHARACTER TYPED
01D9 C40500           CNZ    CPM      ;UNLESS THERE WAS NONE.
01DC 214A06   PRTMX   LXI    H,MAXV   ;SETUP THE MAX AND MIN VALUES FOR THE
01DF 3AD307           LDA    MAX      ;USER TO SEE
01E2 5F               MOV    E,A
01E3 1600             MVI    D,0
01E5 010A03           LXI    B,3*256+10 ;USE DECIMAL
01E8 CD3404           CALL   BTOA
01EB 215A06           LXI    H,MINV
01EE 3AD407           LDA    MIN
01F1 5F               MOV    E,A
01F2 1600             MVI    D,0
01F4 010A03           LXI    B,3*256+10
01F7 CD3404           CALL   BTOA
01FA 112E06           LXI    D,MAXMIN ;PRINT THIS DATA NOW
01FD 0E09             MVI    C,9
01FF CD0500           CALL   CPM
0202 C31E01           JMP    WHAT
              ;
              ;  PRINT OUT THE IMAGE. THERE ARE TWO TONE ARRAYS THAT WILL BE
              ; USED FOR EACH LINE SUCH THAT 'OVERSTRIKE' MAY BE USED WITH A
              ; PRINTER THAT DOES NOT BACKSPACE. EACH TONE ARRAY WILL BE
              ; CONSIDERED SEPERATLY (THEY DON'T HAVE TO BE THE SAME LENGTH).
              ; THIS WILL ALLOW THE USER TO HAVE LOTS OF CONTROL OVER THE
              ; OUTPUT, IF HE/SHE CAN EVER DECIDE ON WHICH CHARACTERS TO USE.
              ;
              ;
0205 119F05   PRT     LXI    D,POS    ;TELL USER TO READY PAPER
0208 CDF303           CALL   ASK
020B 3AD607           LDA    LINES    ;THIS IS HOW LONG THE SCAN IS
020E 47               MOV    B,A
020F 21D707           LXI    H,BUFF   ;THE SCAN DATA STARTS HERE.
0212 EB       PRTLP   XCHG            ;MOVE DATA ADDRESS TO (DE)
0213 C5               PUSH   B        ;SAVE LENGTH
0214 211107           LXI    H,TONE1  ;THIS IS THE PRIMARY TONE ARRAY
0217 3A1007           LDA    NUMBR1   ;AND ITS LENGTH
021A D5               PUSH   D        ;SAVE DATA ADDRESS
021B CD4E02           CALL   PRINTLN  ;PRINT THIS LINE
021E D1               POP    D        ;RESTORE DATA ADDRESS
021F 215307           LXI    H,TONE2  ;NOW USE THE SECONDARY TONE ARRAY
0222 3A5207           LDA    NUMBR2   ;NOTE THAT THIS IS ZERO IF THERE IS
0225 A7               ANA    A        ;NO SECONDARY ARRAY.
0226 D5               PUSH   D        ;SAVE ADDRESS
0227 C44E02           CNZ    PRINTLN
022A E1               POP    H        ;SET (HL) TO START OF LINE JUST PRINTED.
022B CDFD03           CALL   CHECK    ;CHECK THE KEYBOARD
022E DA4502           JC     POUT     ;AND QUIT IF ANYTHING IS PRESENT
0231 1E0A             MVI    E,10     ;ADD A (LF) TO THE OUTPUT FOR THE NEXT
0233 CD0A04           CALL   PRINT    ;LINE.
0236 3AD507           LDA    LNGTH    ;COMPUTE START OF NEXT LINE
0239 5F               MOV    E,A
023A 1600             MVI    D,0
023C 19               DAD    D        ;(HL) HAS START ADDRESS NOW
023D C1               POP    B        ;DECREMENT LINE COUNTER.
023E 05               DCR    B
023F C21202           JNZ    PRTLP
0242 C31E01           JMP    WHAT     ;BACK TO OPTION SELECTION LEVEL
0245 C1       POUT    POP    B        ;SET STACK STRAIGHT
0246 0E01             MVI    C,1      ;GET CHARACTER TYPED
0248 CD0500           CALL   CPM
024B C31E01           JMP    WHAT     ;BUT IGNORE
              ;
```

Listing 1 continued on page 228

MULTI-USER OASIS HAS THE FEATURES PROS DEMAND. READ WHY.

(THEN COMPARE.)

Computer experts (the pros) usually have big computer experience. That's why when they shop system software for Z80 micros, they look for the big system features they're used to. And that's why they like Multi-User OASIS. You will too.

DATA INTEGRITY: FILE & AUTOMATIC RECORD LOCKING

The biggest challenge for any multi-user system is co-ordinating requests from several users to change the same record at the same time.

Without proper co-ordination, the confusion and problems of inaccurate or even destroyed data can be staggering.

Our File and Automatic Record Locking features solve these problems.

For example: normally all users can view a particular record at the same time. But, if that record is being updated by one user, automatic record locking will deny all other users access to the record until the up-date is completed. So records are always accurate, up-to-date and integrity is assured.

Pros demand file & automatic record locking. OASIS has it.

SYSTEM SECURITY: LOGON, PASSWORD & USER ACCOUNTING

Controlling who gets on your system and what they do once they're on it is the essence of system security.

Without this control, unauthorized users could access your programs and data and do what they like. A frightening prospect isn't it?

And multi-users can multiply the problem.

But with the Logon, Password and Privilege Level features of Multi-User OASIS, a system manager can specify for each user which programs and files may be accessed—and for what purpose.

Security is further enhanced by User Accounting—a feature that lets you keep a history of which user has been logged on, when and for how long.

Pros insist on these security features. OASIS has them.

EFFICIENCY: RE-ENTRANT BASIC

A multi-user system is often not even practical on computers limited to 64K memory.

OASIS Re-entrant BASIC makes it practical.

How?

Because all users use a single run-time BASIC module, to execute their compiled programs, less memory is needed. Even if you have more than 64K, your pay-off is cost saving and more efficient use of all the memory you have available—because it services more users.

Sound like a pro feature? It is. And OASIS has it.

AND LOTS MORE...

Multi-User OASIS supports as many as 16 terminals and can run in as little as 56K memory. Or, with bank switching, as much as 784K.

Multi-Tasking lets each user run more than one job at the same time.

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Put it all together and it's easy to see why the real pros like OASIS. Join them. Send your order today.

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Listing 1 continued:

```
                ;   PRINT OUT ONE LINE OF IMAGE DATA. ONE ENTRY, (HL) POINTS TO
                ; THE TONE ARRAY TO USE AND (A) CONTAINS ITS LENGTH. THE SCAN
                ; DATA TO USE IS POINTED TO BY (DE). ALL REGISTERS ARE USED BY
                ; THIS ROUTINE AND NOT RESTORED.
                ;
                ;
                ;
024E 4F         PRINTLN MOV     C,A     ;SAVE LENGTH OF TONE ARRAY.
024F 3AD407             LDA     MIN     ;COMPUTE (MAX-MIN)/LENGTH
0252 47                 MOV     B,A
0253 3AD307             LDA     MAX
0256 90                 SUB     B
0257 0600               MVI     B,0
0259 91         DIVLP   SUB     C
025A DA6102             JC      D1
025D 04                 INR     B
025E C35902             JMP     DIVLP
0261 78         D1      MOV     A,B
0262 320707             STA     SCALE   ;SAVE RESULT HERE
0265 A7                 ANA     A       ;REJECT BAD IMAGE DATA
0266 C8                 RZ
0267 EB                 XCHG            ;(HL)=SCAN DATA, (DE)=TONE ARRAY
0268 D5                 PUSH    D       ;AND SAVE THIS ON THE STACK
0269 3AD507     OUTLP1  LDA     LNGTH   ;COLUMN LIMIT
026C 47                 MOV     B,A
026D 3AD407     INLP1   LDA     MIN     ;COMPUTE: (DATA-MIN)/SCALE
0270 96                 SUB     M       ;NOW (A)=MIN-DATA
0271 2F                 CMA
0272 3C                 INR     A       ;NOW (A)=DTAT-MIN
0273 F5                 PUSH    PSW
0274 3A0707             LDA     SCALE
0277 5F                 MOV     E,A
0278 F1                 POP     PSW
0279 1600               MVI     D,0
027B 93         DIVLP1  SUB     E
027C DA8302             JC      D2
027F 14                 INR     D
0280 C37B02             JMP     DIVLP1
0283 79         D2      MOV     A,C     ;DON'T ALLOW IT TO BE TOO BIG
0284 3D                 DCR     A
0285 BA                 CMP     D
0286 DA8A02             JC      D3
0289 7A                 MOV     A,D     ;ITS OK, JUST USE IT.
028A D1         D3      POP     D       ;GET THE A(TH) BYTE FROM THE TONE STRING
028B D5                 PUSH    D
028C 83                 ADD     E
028D 5F                 MOV     E,A
028E 3E00               MVI     A,0
0290 8A                 ADC     D
0291 57                 MOV     D,A
0292 1A                 LDAX    D       ;GET THE BYTE TO PRINT
0293 5F                 MOV     E,A
0294 CD0A04             CALL    PRINT
0297 23                 INX     H       ;NEXT BYTE
0298 05                 DCR     B
0299 C26D02             JNZ     INLP1
029C 1E0D               MVI     E,13    ;ADD (CR)
029E CD0A04             CALL    PRINT
02A1 D1                 POP     D       ;CLEANUP STACK
02A2 C9                 RET             ;AND BACK OUT
                ;
                ;   FILE THE DATA AWAY ON THE SUER SPECIFIED FILE. ON ENTRY TO
                ; IMAGE, THIS FILENAME WAS SPECIFIED (HOPEFULLY) AND WE HAVE
                ; ALREADY ADDED THE EXTENSION 'IMG' TO IT. IF THE INDICATED
                ; FILE ALREADY EXISTS, IT WILL BE DELETED AND A NEW FILE IS
                ; CREATED. THE INFORMATION SAVED WILL BE THE SCAN DATA ARRAY
                ; ITSELF, THE MAXIMUM AND MINIMUM VALUES IN THIS ARRAY, THE
                ; NUMBER OF SCAN LINES PRESENT, AND THE LENGTH OF EACH LINE.
                ; THIS DATA MAY BE READ BACK IN AT ANOTHER TIME WITH THE 'R'
                ; COMMAND.
                ;
                ;
02A3 3A0807     FILE    LDA     NSECT   ;CHECK FOR ANYTHING TO FILE
02A6 A7                 ANA     A
02A7 CA0403             JZ      NOTHING
```

Listing 1 continued on page 230

Circle 154 on inquiry card.

Listing 1 continued:

```
02AA 115C00          LXI   D,005CH ;USE DEFAULT FCB
02AD 0E13            MVI   C,19    ;DELETE THE FILE
02AF CD0500          CALL  CPM
02B2 115C00          LXI   D,005CH
02B5 0E16            MVI   C,22    ;CREATE IT NOW
02B7 CD0500          CALL  CPM
02BA 115C00          LXI   D,005CH
02BD 0E0F            MVI   C,15    ;AND OPEN IT.
02BF CD0500          CALL  CPM
02C2 3C              INR   A
02C3 C2D102          JNZ   F1
02C6 11B805   ERR    LXI   D,ERR1
02C9 0E09            MVI   C,9
02CB CD0500          CALL  CPM     ;NO ROOM
02CE C30000          JMP   0
02D1 21D307   F1     LXI   H,MAX   ;THIS IS WHERE IT IS STORED.
02D4 AF              XRA   A       ;SET INITIAL SECTOR COUNTER TO ZERO
02D5 327C00          STA   005CH+32;IN DEFAULT FCB.
02D8 3A0807          LDA   NSECT   ;AND THIS IS HOW LONG
02DB F5       FILELP PUSH  PSW
02DC E5              PUSH  H
02DD EB              XCHG          ;SET THE TRANSFER ADDRESS
02DE 0E1A            MVI   C,26
02E0 CD0500          CALL  CPM
02E3 0E15            MVI   C,21    ;WRITE THIS SECTOR
02E5 115C00          LXI   D,005CH
02E8 CD0500          CALL  CPM
02EB E1              POP   H
02EC A7              ANA   A       ;CHECK STATUS OF LAST WRITE
02ED C2C602          JNZ   ERR     ;MUST BE OUT OF SPACE
02F0 118000          LXI   D,128   ;COMPUTE ADDRESS OF NEXT
02F3 19              DAD   D
02F4 F1              POP   PSW
02F5 3D              DCR   A
02F6 C2DB02          JNZ   FILELP
02F9 115C00          LXI   D,005CH ;CLOSE THE FILE NOW
02FC 0E10            MVI   C,16
02FE CD0500          CALL  CPM
0301 C31E01          JMP   WHAT
              ;
0304 115F06   NOTHING LXI  D,NONE  ;TELL USER TO SCAN SOMETHING FIRST.
0307 0E09            MVI   C,9
0309 CD0500          CALL  CPM
030C C31E01          JMP   WHAT
              ;
              ;   READ IN THE FILE THAT WAS GIVEN IN THE INITIAL COMMAND.
              ;
030F 115C00   READF  LXI   D,005CH ;OPEN THIS FILE
0312 0E0F            MVI   C,15
0314 CD0500          CALL  CPM
0317 3C              INR   A       ;WAS THIS FILE PRESENT ?
0318 CA4F03          JZ    NOFILE
031B 21D307          LXI   H,MAX   ;PUT THE DATA HERE
031E AF              XRA   A       ;SET INITIAL SECTOR COUNTER TO ZERO
031F 327C00          STA   005CH+32;IN DEFAULT FCB.
0322 F5       READLP PUSH  PSW
0323 E5              PUSH  H
0324 EB              XCHG          ;SET THE TRANSFER ADDRESS
0325 0E1A            MVI   C,26
0327 CD0500          CALL  CPM
032A 115C00          LXI   D,005CH ;READ A SECTOR
032D 0E14            MVI   C,20
032F CD0500          CALL  CPM
0332 A7              ANA   A       ;ZERO IS A GOOD READ
0333 C24003          JNZ   READDN
0336 118000          LXI   D,128
0339 E1              POP   H
033A 19              DAD   D       ;COMPUTE NEXT ADDRESS
033B F1              POP   PSW     ;COUNT THEM SECTORS READ.
033C 3C              INR   A
033D C32203          JMP   READLP
0340 F1       READDN POP   PSW     ;SAVE SECTORS READ
0341 320807          STA   NSECT
0344 115C00          LXI   D,005CH ;CLOSE THE FILE
0347 0E10            MVI   C,16
0349 CD0500          CALL  CPM
```

Listing 1 continued on page 232

Listing 1 continued:

```
034C C3DC01          JMP     PRTMX    ;GIVE DENSITY LIMITS.
                ;
034F 117706     NOFILE  LXI     D,NFMSG  ;TELL USER THAT THIS FILE IS NOT
0352 0E09               MVI     C,9      ;SAVED.
0354 CD0500             CALL    CPM
0357 C31E01             JMP     WHAT     ;BACK TO OPTION LEVEL
                ;
                ;   SET THE TONE ARRAYS TO THE USER'S CHOICE. BOTH THE PRIMARY
                ; AND SECONDARY TONE ARRAYS MUST BE SET. EITHER ONE MAY BE BLANK.
                ;
035A 11D405     TSET    LXI     D,MSG1
035D 0E09               MVI     C,9
035F CD0500             CALL    CPM
0362 110F07             LXI     D,INPUT1 ;PUT THE STRING HERE
0365 0E0A               MVI     C,10     ;USE CP/M'S LINE INPUT ROUTINE
0367 CD0500             CALL    CPM
036A 110E06             LXI     D,MSG2   ;ASK FOR SECONDARY ARRAY
036D 0E09               MVI     C,9
036F CD0500             CALL    CPM
0372 115107             LXI     D,INPUT2 ;PUT IT HERE
0375 0E0A               MVI     C,10
0377 CD0500             CALL    CPM
037A C31E01             JMP     WHAT     ;NOTHING TO IT.
                ;
                ;
                ;   SECTION TO GET THE DESIRED MAXIMUM AND MINIMUM VALUES FROM
                ; THE USER. THESE VALUES WILL REPLACE THOSE FOUND BY SCANNING
                ; THE DATA RECEIVED FROM THE A/D. THIS WILL BE NECESSARY FOR
                ; THOSE CASES WHERE A PICTURE WAS BROKEN UP INTO MORE THAN ONE
                ; IMAGE (DUE TO SIZE) AND A CONSISTANT SET OF CHARACTER
                ; SUBSTITUTIONS IS DESIRED.
                ;
                ;
037D 119F06     SETMAX  LXI     D,SETMX  ;TELL USER WHICH ONE TO TYPE.
0380 0E09               MVI     C,9
0382 CD0500             CALL    CPM
0385 CD9C03             CALL    GETNUM   ;AND GET IT.
0388 32D307             STA     MAX      ;AND SAVE IT.
038B 11D006             LXI     D,SETMN  ;NOW DO THE SAME FOR THE MIN VALUE.
038E 0E09               MVI     C,9
0390 CD0500             CALL    CPM
0393 CD9C03             CALL    GETNUM
0396 32D407             STA     MIN
0399 C31E01             JMP     WHAT     ;NO CHECK IS MADE FOR LEGAL VALUES.
                ;
                ;
                ;   ROUTINE TO READ IN A DECIMAL NUMBER TYPED BY THE USER. THE
                ; RESULTING VALUE IS RETURNED IN REGISTER (A). ALL REGISTERS ARE
                ; USED AND NOT RESTORED.
                ;
                ;
039C 110907     GETNUM  LXI     D,INBUFF ;INPUT BUFFER TO USE
039F D5                 PUSH    D
03A0 0E0A               MVI     C,10
03A2 CD0500             CALL    CPM      ;USE CP/M'S INPUT ROUTINE TO ALLOW
03A5 AF                 XRA     A        ;CORRECTIONS. CLEAR THE ACCUMULATOR.
03A6 E1                 POP     H        ;POINT TO BUFFER
03A7 23                 INX     H        ;AND SKIP OVER BOTH COUNTERS
03A8 4E                 MOV     C,M      ;GET COUNT AND SAVE IN (C).
03A9 23         GETNM1  INX     H
03AA 47                 MOV     B,A      ;SAVE RESULTING VALUE IN (B)
03AB 7E                 MOV     A,M      ;GET A CHARACTER
03AC D630               SUI     '0'      ;MAKE BINARY
03AE FAC403             JM      BADNUM
03B1 FE0A               CPI     10       ;LEGAL?
03B3 D2C403             JNC     BADNUM
03B6 57                 MOV     D,A      ;IT'S OK, SAVE IT HERE.
03B7 78                 MOV     A,B      ;MULTIPLY PREVIOUS TOTAL BY 10.
03B8 A7                 ANA     A        ;CLEAR THE CARRY FLAG.
03B9 17                 RAL
03BA 5F                 MOV     E,A
03BB 17                 RAL
03BC 17                 RAL
03BD 83                 ADD     E
03BE 82                 ADD     D        ;ADD IN NEW DIGIT.
03BF 0D                 DCR     C        ;DO ALL DIGITS.
03C0 C2A903             JNZ     GETNM1
```

Listing 1 continued on page 234

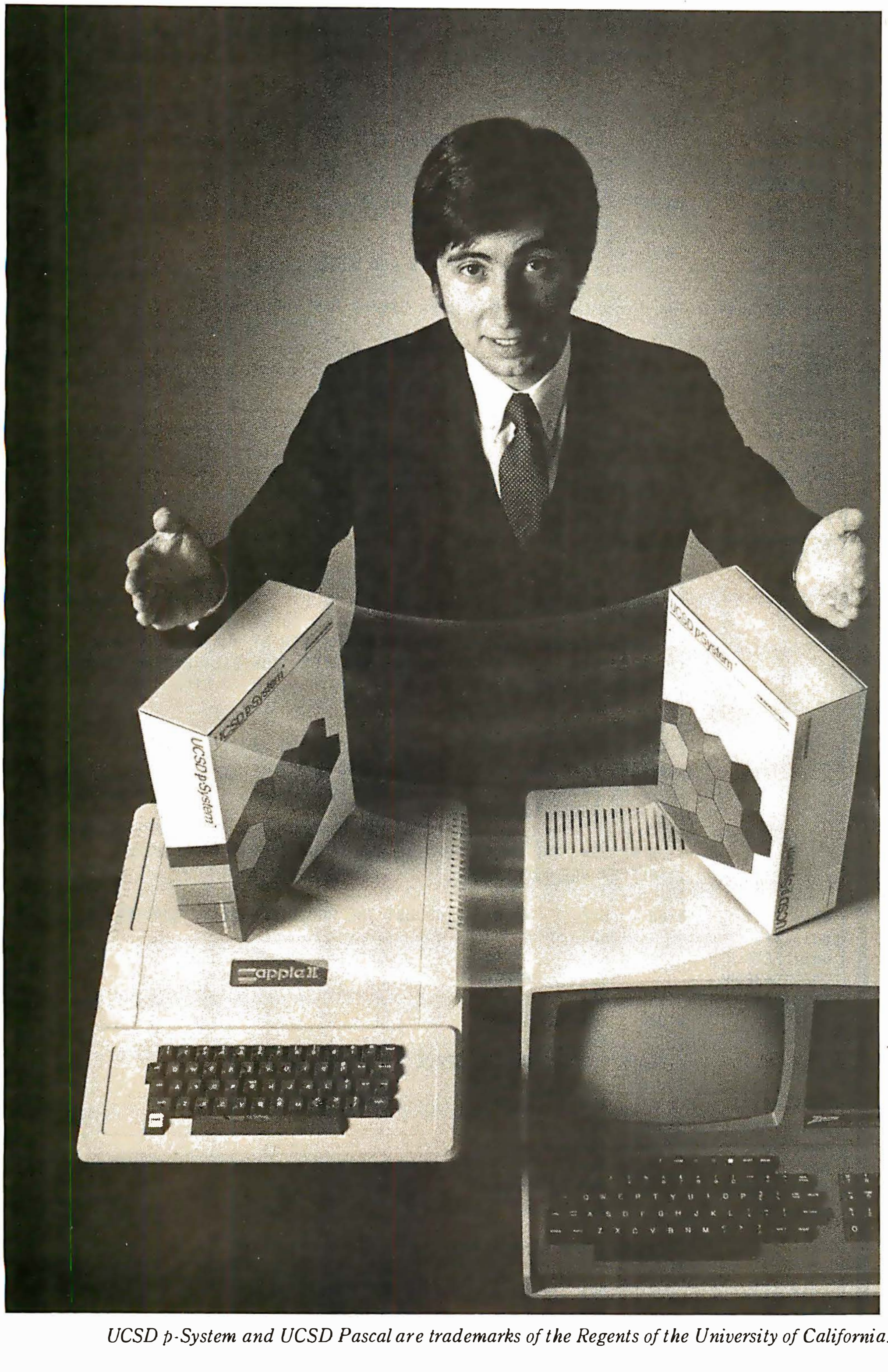
Listing 1 continued:

```
03C3 C9                 RET                 ;ALL DONE, RESULT IS IN (A).
                ;
03C4 11DD06     BADNUM  LXI     D,BADINP    ;TELL USER TO TRY AGAIN.
03C7 0E09               MVI     C,9
03C9 CD0500             CALL    CPM
03CC C39C03             JMP     GETNUM
                ;
                ;
                ;  READ THE A/D AND AVERAGE OVER EIGHT READS TO REDUCE THE
                ; SCATTER THAT IS BOUND TO EXIST WITH THIS SIMPLE IMAGE
                ; PROCESSING SYSTEM.
                ;
03CF E5         READ    PUSH    H
03D0 C5                 PUSH    B
03D1 210000             LXI     H,0         ;KEEP SUM HERE
03D4 0608               MVI     B,8
03D6 CD1604     RLP1    CALL    ATOD        ;READ THE A/D
03D9 85                 ADD     L           ;ADD VALUE TO OUR SUM
03DA 6F                 MOV     L,A
03DB 3E00               MVI     A,0
03DD 8C                 ADC     H
03DE 67                 MOV     H,A
03DF 05                 DCR     B
03E0 C2D603             JNZ     RLP1
03E3 0603               MVI     B,3         ;NOW DIVIDE BY 8
03E5 A7         RLP2    ANA     A           ;CLEAR CARRY
03E6 7C                 MOV     A,H
03E7 1F                 RAR
03E8 67                 MOV     H,A
03E9 7D                 MOV     A,L
03EA 1F                 RAR
03EB 6F                 MOV     L,A
03EC 05                 DCR     B
03ED C2E503             JNZ     RLP2
03F0 C1                 POP     B
03F1 E1                 POP     H
03F2 C9                 RET
                ;
                ;  UTILITY ROUTINES...
                ;
                ;
                ; ASK A MESSAGE POINTED TO BY (DE), AND GET A ONE CHARACTER
                ; RESPONCE. THE RESPONCE IS RETURNED IN (A). ALL REGISTERS
                ; ARE USED AND NOT RESTORED.
                ;
03F3 0E09       ASK     MVI     C,9         ;PRINT MESSAGE AND GET RESPONCE
03F5 CD0500             CALL    CPM
03F8 0E01               MVI     C,1
03FA C30500             JMP     CPM
                ;
                ;  CHECK THE KEYBOARD TO SEE IF ANYTHING IS READY. ON SYSTEMS
                ; THAT LATCH THE OUTPUT FROM THE TERMINAL, THE USER JUST HITS
                ; A KEY AND THEN THIS WILL DETECT IT. ON OTHER TYPES (LIKE MINE),
                ; THE USER MUST HOLD THE KEY DOWN UNTIL THIS ROUTINE IS CALLED.
                ; A MINOR INCONVENIENCE. ALL REGISTERS EXCEPT (A) ARE SAVED.
                ; IF A KEY IS TYPED, THEN THIS WILL RETURN WITH THE CARRY FLAG
                ; SET.
                ;
03FD C5         CHECK   PUSH    B           ;CHECK THE KEYBOARD FOR ANYTHING
03FE E5                 PUSH    H
03FF D5                 PUSH    D
0400 0E0B               MVI     C,11
0402 CD0500             CALL    CPM
0405 D1                 POP     D
0406 E1                 POP     H
0407 C1                 POP     B
0408 1F                 RAR
0409 C9                 RET
                ;
                ;
                ;  SEND ONE CHARACTER TO THE LIST DEVICE. THE CHARACTER MUST BE
                ; IN REGISTER (E) AND ALL REGISERS (EXCEPT A) ARE SAVED.
                ;
040A C5         PRINT   PUSH    B           ;PRINT (E)
040B E5                 PUSH    H
040C D5                 PUSH    D
040D 0E05               MVI     C,5
040F CD0500             CALL    CPM
```

Listing 1 continued on page 236

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Listing 1 continued:

```
0412 D1              POP     D
0413 E1              POP     H
0414 C1              POP     B
0415 C9              RET
                ;
                ;
                ;   READ THE A/D. IT IS ASSUMED HERE THAT THE SETUP IS SIMILAR
                ; TO THAT PROPOSED IN DDJ, OCTOBER 1979. HERE, THE D/A IS
                ; CONNECTED TO OUTPUT PORT 2, AND THE RESULT OF THE COMPARITOR
                ; IS READ FROM INPUT PORT 2, BIT 0. FOR THE DIGITAL GROUP SYSTEM,
                ; THE INPUT DATA WILL BE INVERTED BY THE CPU CARD. IF YOURS DOES
                ; NOT WORK THIS WAY, CHANGE THE 'JNZ' TO A 'JZ' IN THE CODE BELOW.
                ; THE RESULTING VALUE IS RETURNED IN (A) AND ALL OTHER REGISTERS
                ; ARE SAVED. THIS PROCEDURE USES A BINARY SEARCH TECHNIQUE TO FIND
                ; THE VALUE OF THE VOLTAGE INPUT TO THE A/D.
                ;
0416 C5         ATOD PUSH    B          ;READ A/D (.34 MS PER READ AVERAGE).
0417 AF              XRA     A          ;READ THE A/D
0418 0680            MVI     B,128
041A 0E08            MVI     C,8
041C 80       ADLOOP ADD     B          ;SET THE D/A
041D D302            OUT     2
041F F5              PUSH    PSW
0420 DB02            IN      2          ;READ AND CHECK BIT #0
0422 E601            ANI     1
0424 C22A04          JNZ     AD1        ;*** SYSTEM DEPENDENT ***
0427 F1              POP     PSW
0428 90              SUB     B          ;TOO FAR, BACK OFF
0429 F5              PUSH    PSW
042A 78          AD1 MOV     A,B        ;NEXT BIT
042B 1F              RAR
042C 47              MOV     B,A
042D F1              POP     PSW
042E 0D              DCR     C          ;DO ALL 8 BITS
042F C21C04          JNZ     ADLOOP
0432 C1              POP     B
0433 C9              RET
                ;
                ;
                ;   BINARY TO ASCII ROUTINE
                ;
                ;   THIS ROUTINE WILL CONVERT A 16 BIT BINARY NUMBER INTO ASCII
                ;   ACCORDING TO A SPECIFIED RADIX VALUE. THE DIGITS USED ARE:
                ;   0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F,G,H,I,J,K....ETC
                ;
                ; TO USE:
                ; HL=ADDRESS OF A BUFFER FOR THE RESULTING ASCII DIGITS
                ; DE=CONTAINS THE 16 BIT NUMBER TO CONVERT
                ; B =THE MAXIMUM LENGTH OF THE BUFFER
                ; C =THE RADIX TO USE (2,8,16,...ETC)
                ;
                ; ON RETURN, THE CARRY FLAG IS SET IF AN OVER-FLOW OCCURED
                ; (BUFFER WAS TOO SMALL).
                ;
0434 3E30       BTOA MVI     A,'0'      ;ADJUST THE RADIX FOR ASCII CONVERSION
0436 81              ADD     C
0437 FE3B            CPI     '9'+2
0439 DA3E04          JC      BTOA1
043C C607            ADI     7
043E 4F        BTOA1 MOV     C,A
                ;
                ; BLANK OUT THE BUFFER SPACE
                ;
043F 78              MOV     A,B
0440 3620      BTOA2 MVI     M,' '
0442 23              INX     H
0443 3D              DCR     A
0444 C24004          JNZ     BTOA2
0447 2B              DCX     H
                ;
                ; CONVERT THE NUMBER NOW.
                ;
0448 3630            MVI     M,'0'      ;ZERO OUT THE FIRST DIGIT.
044A 7A              MOV     A,D        ;CHECK FOR ZERO
044B B3              ORA     E
044C C8              RZ
044D 34              INR     M
```

Listing 1 continued on page 238



ANALOG INTERFACES



Industrial, Scientific, Laboratory, or Commercial Microcomputer Users-

Industrial quality data conversion boards are available for APPLE, S-100, PET, TRS-80, AIM, and KIM systems. Tecmar can provide individual boards, data conversion subsystems, or complete Data Conversion Systems. Tecmar's growing product line offers outstanding features, meticulous engineering, exceptional documentation, and a seven year record of proven reliability.

KIM AIM TRS-80 TRS-80 KIM AIM

Tecmar's new Analog to Digital Converter Series (AD-200) is designed to meet sophisticated data acquisition needs. The board accommodates various precision A/D modules made by Analogic and Data Translation. These modules are easily interchanged to provide options such as 12, 14, or 16 bit accuracy; 125 KHz throughput; variable ranges and gains.

AD212	S-100 A/D and Timer Board	$695
AD211	Apple A/D Board	$495

AD-200 Features

- 12 bit accuracy and resolution standard
- 30 KHz conversion rate standard
- 16 single-ended or 8 true differential inputs - jumper selectable
- External trigger of A/D
- Output formats: Two's complement, binary, offset binary
- Auto channel incrementing from any channel to any channel
- Data is latched providing pipelining for higher throughputs
- Provision for synchronizing A/Ds
- Utilizes interrupt or status test
- Jumper selectable input ranges: ±10V, ±5V, 0 to +10V, 0 to +5V

In addition the S-100 version:

- Complies with IEEE S-100 specifications
- Transfers data in 8 or 16 bit words
- Provides for expansion to 256 channels
- Is switch selectable I/O or memory mapped

Timer Features on S-100 Board

In addition to the A/D features, the S-100 Board contains a powerful timer circuit which can start A/D conversion and can also be used independently for time of day, event counting, frequency shift keying and many other applications.

- 5 independent 16 bit counters (cascadable)
- 15 lines available for external use
- Time of day
- Event counter
- Alarm comparators on 2 counters
- One shot or continuous frequency outputs
- Complex duty cycle and frequency shift keying outputs
- Programmable gating and count source selection
- Utilizes vectored interrupt

Options for AD-200

• Programmable gain up to 500	$ 175
• 14 bit accuracy	717
• 16 bit accuracy	1,117
• 100 KHz conversion rate	517
• 125 KHz conversion rate	617
• Screw Terminal and Signal Conditioning panel	250
• Thermocouple cold junction compensation	125
• Rack mounting assembly with plexiglass cover	125
• Low level, wide range permitting low level sensors such as thermocouples, pressure sensors and strain gauges to be directly connected to the module input	70

Apple D/A Features $295

- 12 bit accuracy and resolution
- 2 independent digital to analog converters
- 8 parallel latched output lines
- Jumper selectable output ranges: ±10V, ±5V, ±2.5V, 0 to +10V, 0 to +5V
- 3 microsecond conversion time
- Minimal software required
- Optional 4-20 mA board available

S-100 PET[2] TRS-80[1] AIM[3] KIM[2]

The original Tecmar data conversion boards (AD-100 and DA-100) continue to solve less sophisticated conversion problems. These S-100 boards interface to the PET, TRS-80, AIM, and KIM through S-100 expansion interfaces.

AD-100 Features $495

- 12 bit accuracy and resolution
- 30 KHz conversion rate
- 16 single-ended or 8 true differential inputs (specify AD-100S or AD-100D)
- Minimal software required
- I/O or memory mapped operation for S-100 systems - jumper selectable
- Jumper selectable input ranges: ±10V, ±5V, 0 to +10V, 0 to +5V
- IEEE S-100

DA-100 Features $395

- 12 bit accuracy and resolution
- 4 independent digital to analog converters
- 3 microsecond settling time
- Jumper selectable output ranges: ±10V, ±5V, ±2.5V, 0 to +10V, 0 to +5V
- I/O or memory mapped operation for S-100 systems - jumper selectable
- Minimal software required
- IEEE S-100
- Optional 4-20 mA board available

Expansion board, power supply, and enclosure for PET	$250
Expansion board and power supply for TRS-80, KIM, or AIM	150

S-100 Real Time Video Digitizer

- Digitizes and Displays in 1/60 sec, flicker-free
- 16 Gray Levels
- Switch Selectable to display Black and White Graphics (8 pixels/byte)
- Maximum Resolution: 512 pixels/line x 240 lines
- Minimal software requirements **$850**

S-100 BOARDS

8086 CPU W/vectored interrupts	$450
RAM 8Kx16/16Kx8	$395
8086 PROM-I/O	$495
Serial and Parallel I/O	$350
Parallel I/O & Timer	$350

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Circle 162 on inquiry card.

Listing 1 continued:

```
044E 1B         BLP     DCX     D       ;ROLL DOWN COUNTER
044F 7B                 MOV     A,E     ;IS IT ZERO YET ?
0450 B2                 ORA     D
0451 C8                 RZ              ;YES THEN WE ARE DONE.
                ;
                ; ROLL UP THE RESULT IN ODOMETER FASHION
                ;
0452 E5                 PUSH    H       ;KEEP REGS
0453 C5                 PUSH    B
0454 7E         BTOA3   MOV     A,M
0455 3C                 INR     A
0456 B9                 CMP     C       ;REACHED RADIX LIMIT ?
0457 C26C04             JNZ     BTOA4
045A 3630               MVI     M,'0'   ;YES, RESET THIS DIGIT TO ZERO AND WORK
045C 2B                 DCX     H       ;ON THE NEXT (IF THERE IS ONE).
045D 05                 DCR     B
045E CA7504             JZ      BTOA5   ;OVER-FLOW
0461 7E                 MOV     A,M     ;CHANGE A BLANK INTO A ZERO FIRST TIME HERE
0462 FE20               CPI     ' '
0464 C25404             JNZ     BTOA3
0467 3630               MVI     M,'0'
0469 C35404             JMP     BTOA3
046C 77         BTOA4   MOV     M,A     ;CHECK FOR A DIGIT >9 AND BUMP PAST SOME
046D FE3A               CPI     '9'+1   ;ASCII JUNK
046F C27504             JNZ     BTOA5
0472 C607               ADI     7
0474 77                 MOV     M,A
                ;
                ; RESTORE THE REGS AND CONTINUE UNLESS THE ZERO FLAG IS SET.
                ;
0475 C1         BTOA5   POP     B
0476 E1                 POP     H
0477 C24E04             JNZ     BLP
047A 37                 STC             ;SET THE CARRY ON AN OVER-FLOW ERROR
047B C9                 RET
                ;
                ;
                ;   MESSAGE AREA
                ;
                ;
047C 0D0A494D41HELLO    DB      13,10,'IMAGE   Image Processing Program'
049E 2020207665         DB      '    ver 2.00    11-05-79$'
04B5 0D0A4D656EOPTION   DB      13,10,'Menue:',13,10
04BF 463D46696C         DB      'F=File the data',13,10
04D0 483D48656C         DB      'H=Help, display menue',13,10
04E7 4D3D536574         DB      'M=Set the maximum and minimum values',13,10
050D 503D507269         DB      'P=Print the data back out',13,10
0528 513D517569         DB      'Q=Quit and return to CP/M',13,10
0543 523D526561         DB      'R=Read the file in',13,10
0557 533D536361         DB      'S=Scan a new page',13,10
056A 543D536574         DB      'T=Set the tone array',13,10
0580 24                 DB      '$'
0581 0D0A4F7074QUESTN   DB      13,10,'Option (F,H,M,P,Q,R,S,T) ? $'
059F 0D0A506F73POS      BB      13,10,'Position paper (space)$'
05B8 0D0A446973ERR1     DB      13,10,'Disk or directory is full$'
05D4 0D0A456E74MSG1     DB      13,10,'Enter density characters (max to min),'
05FC 3C7265743E         DB      '<ret>',13,10,'Primary -?$'
060E 0D0A536563MSG2     DB      13,10,'Secondary -?$'
061D 0D0A4C696ELLNGTH   DB      13,10,'Line length -?$'
062E 0D0A496D61MAXMIN   DB      13,10,'Image scanned: Max value ='
064A 3030302C20MAXV     DB      '000, min value ='
065A 3030302E24MINV     DB      '000.$'
065F 0D0A4E6F20NONE     DB      13,10,'No image was scanned.$'
0677 0D0A4E6F20NFMSG    DB      13,10,'No scan data was saved for this file.$'
069F 0D0A536574SETMX    DB      13,10,'Setting maximum and minimum values'
06C3 0D0A4D6178         DB      13,10,'Maximum ? $'
06D0 0D0A4D696ESETMN    DB      13,10,'Minimum ? $'
06DD 0D0A4F6E6CBADINP   DB      13,10,'Only digits 0-9 are allowed, retry.'
0702 0D0A3F2024         DB      13,10,'? $'
                ;
                ;
                ;   DATA STORAGE AREA
                ;
0707 00         SCALE   DB      0
0708 00         NSECT   DB      0       ;SECTORS USED IN SCAN
0709 0400000000INBUFF   DB      4,0,0,0,0,0 ;NUMERIC INPUT BUFFER
070F 40         INPUT1  DB      64      ;MAX LENGTH OF PRIMARY TONE ARRAY
0710 1E         NUMBR1  DB      30      ;CURRENT LENGTH
```

Listing 1 continued on page 240



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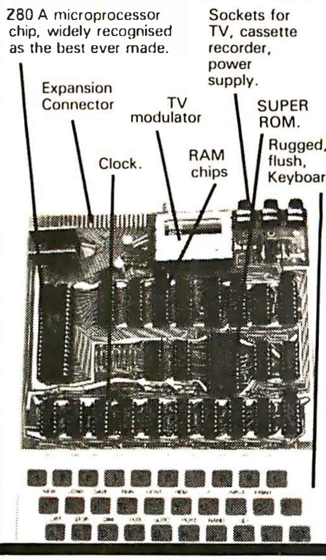
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Text continued from page 222:
collected onto the file specified in the initial command "filename". If this file already exists, it will be deleted. This allows the user to keep the basic data for processing at a later time. When completed, the user is returned to the option-selection level. Two possible errors may occur here:

- "Disk or directory full". This means that you don't have enough room on the current disk to save all the data. Sorry, you will have to start over. Note that the storage space required is 1 byte per column per line.
- "No image was scanned". Here, you must scan an image before trying to file the data.

H: Help Me

The user can type H to view the whole menu again. Normally only the "option" line is printed.

M: Set the Maximum and Minimum Values

This option allows the user to specify what values are to be used in place of the actual maximum and minimum values in the data array. This is necessary when you want to print two separate pictures with the same character-substitution sequence. (For example, this is the case when, due to its size, a picture was broken up into two or more sections.) The numbers are entered as decimal numerals in the range 0 to 255. If the data is *filed* after making this change, the new maximum and minimum values will be permanent.

P: Print the Data

When you are ready to print the image, with the character-substitution array set and an image scanned, this option will give you time to change the paper and position the carriage by issuing the following message:

Position paper (space)

Hit the space bar when ready to begin. The program scales all of the light intensity levels stored so that the picture fits the length of character-substitution array entered. (Both the primary and secondary arrays are treated separately.) To terminate the printed listing prior to the actual end of the data, type any key. You are returned to the option-selection level.

Listing 1 continued:

```
0711 4045252423TONE1   DB      '@EZ$H;1*H@7AZHN8$032I7*+(!',39,'-',39,' '
072F                   DS      34
0751 40         INPUT2 DB      64      ;SECONDARY TONE ARRAY
0752 1E         NUMBR2 DB      30      ;ITS CURRENT LENGTH
0753 2323232323TONE2   DB      '########!!!!!                ',39,'    '
0771                   DS      34
0793                   DS      64      ;STACK AREA
07D3 =          STACK  EQU     $
                ;
                ;
                ; THE FOLLOWING DATA IS SAVED ON THE FILE.
                ;
 07D3 00        MAX     DB     0       ;MAXIMUM VALUE IN ARRAY
 07D4 00        MIN     DB     0       ;MINIMUM VALUE
 07D5 00        LNGTH   DB     0       ;LINE LENGTH
 07D6 00        LINES   DB     0       ;NUMBER OF LINES
 07D7 =         BUFF    EQU    $       ;START DATA ARRAY HERE.
                ;
                ;
 0005 =         CPM     EQU    5       ;ENTRY TO THE SYSTEM.
                ;
 07D7                   END    100H
042A AD1       041C ADLOOP    03F3 ASK       0416 ATOD      06DD BADINP
03C4 BADNUM    044E BLP       0434 BTOA      043E BTOA1     0440 BTOA2
0454 BTOA3     046C BTOA4     0475 BTOA5     07D7 BUFF      03FD CHECK
0005 CPM       018C D01       0197 D02       01A5 D03       0261 D1
0283 D2        028A D3        01C2 DELAY     0259 DIVLP     027B DIVLP1
02C6 ERR       05B8 ERR1      02D1 F1        02A3 FILE      02DB FILELP
03A9 GETNM1    039C GETNUM    047C HELLO     0100 IMAGE     0709 INBUFF
017D INLP      026D INLP1     070F INPUT1    0751 INPUT2    07D6 LINES
061D LLNGTH    07D5 LNGTH     07D3 MAX       062E MAXMIN    064A MAXV
07D4 MIN       065A MINV      05D4 MSG1      060E MSG2      0677 NFMSG
034F NOFILE    065F NONE      0304 NOTHING   0708 NSECT     0710 NUMBR1
0752 NUMBR2    0116 OPT       04B5 OPTION    0179 OUTLP     0269 OUTLP1
059F POS       0245 POUT      040A PRINT     024E PRINTLN   0205 PRT
0212 PRTLP     01DC PRTMX     0581 QUESTN    0340 READDN    030F READF
03CF READ      0322 READLP    03D6 RLP1      03E5 RLP2      0707 SCALE
014C SCAN      037D SETMAX    06D0 SETMN     069F SETMX     07D3 STACK
0711 TONE1     0753 TONE2     01CF TOUT      035A TSET      011E WHAT
```





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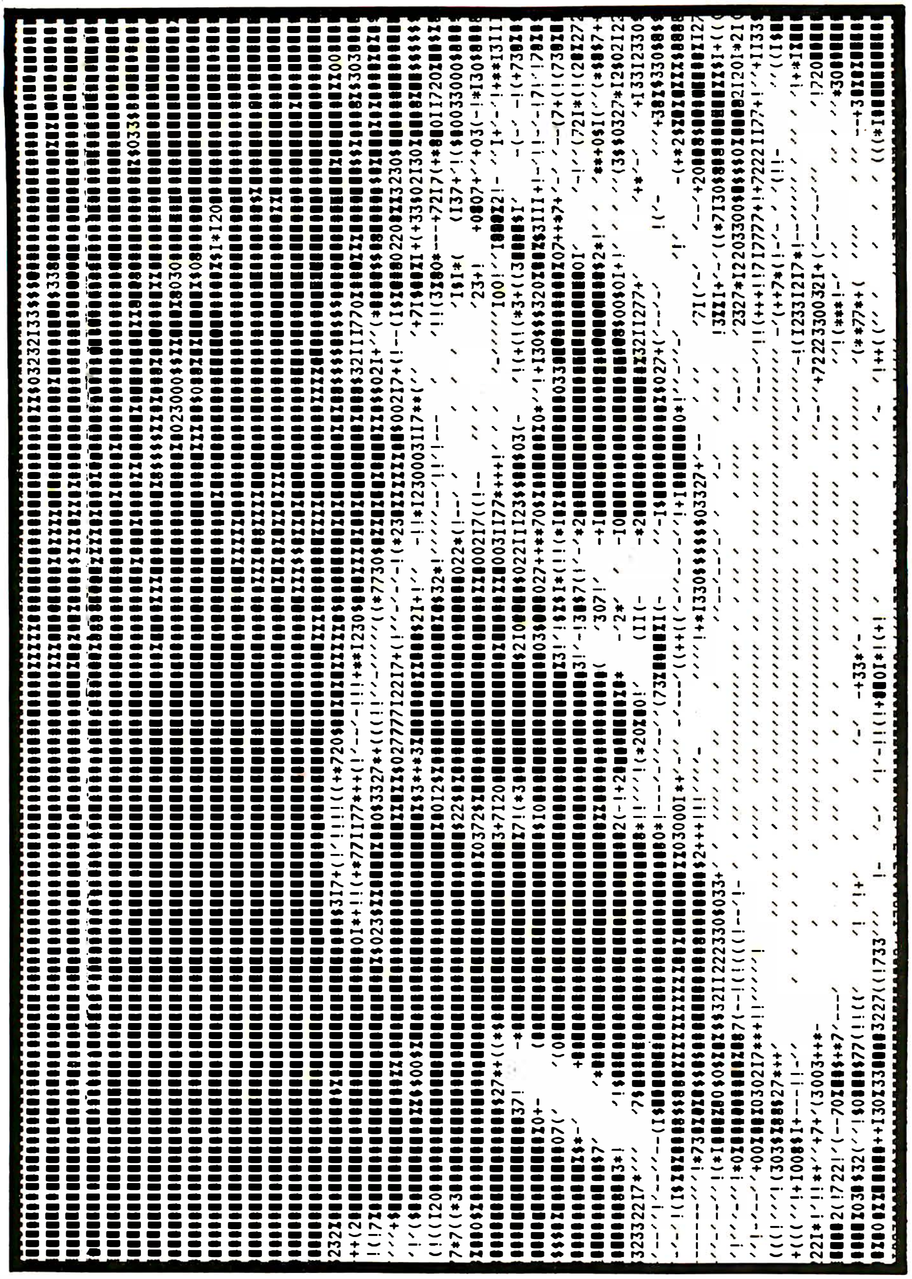
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Q: Quit and Return to CP/M

This returns control directly to CP/M. If you want to save the collected data, this must be done prior to quitting the program.

R: Read In the File

The current disk will be searched for "filename.img", as specified in the initial command. If it is found, the entire data file will be read into memory. The maximum and minimum values associated with the data will be printed. If the file cannot be found, then an appropriate message will be printed and the user will be returned to the option-selection level.

S: Scan a New Page

The length of the scan line will be asked first. Type in the decimal number of characters per line (1 to 255). You will be given a chance to position the paper before the scan is started. Hit the space bar to begin. The program will scan over the image in the print device until 255 lines have been scanned or a key has been hit. The maximum and minimum values read from the A/D converter are printed, and control is returned to the option-selection level.

T: Set the Tone Array

This is the heart of the processing system. For each column position, up to two characters will be typed to represent the A/D-determined intensity at this point. To accomplish this character substitution, two tone arrays are used. A *primary* tone array is always used and consists of up to sixty-four characters chosen by the user. They are entered in the order of maximum darkness to minimum darkness. (Minimum darkness is usually a space.) A *secondary* tone array can also be given for overstriking characters to achieve greater density variation. This array, if given, is generally the same length as the primary array, although this is not required. The program will determine which character to use for any given value read from the A/D converter by the procedure:

```
SCALE=(MAX-MIN)/N
INDEX=(VALUE-MIN)/SCALE
if INDEX > N-1 then INDEX=N-1
```

where:

MAX=the maximum integer value in data.
MIN=the minimum integer value in data.
N=the integer number of characters in the tone array.
VALUE=the integer value read from the A/D converter for this position.
SCALE=the integer scale factor to use.
INDEX=the integer index into the tone array (0 to N-1).

The result of these computations (INDEX) specifies which of the *N* characters in the tone array will be used. A 0 refers to the first (or maximum density) character and (N-1) refers to the last available character (the minimum density). Note the value of (INDEX) is prevented from being greater than (N-1).

Integer arithmetic is used for all computations and, as such, the number of characters in the tone array affects the scale factor used. If the number of characters in the tone array is not an even divisor of the maximum-to-minimum variation, then the truncation that occurs in computing the scale factor has the effect of extending the minimum-density character until the number is an even divisor. This can cause large blank areas to appear in the final printout.

The tone arrays are entered using CP/M's buffered input routine. This means that all normal correction keys can be used on mistakes. Type a carriage return to end the line. To skip


C
IDRIS
PASCAL

```
Primary - "@EZ$#;1*#@7AZ#N8$032I7*+(!'-'  "

Secondary-"########!!!!!             '     "
```

Table 2: *The primary and secondary image-tone character arrays, with high-intensity correspondence increasing from left to right.*

the secondary tone array, just type a return. This doubles the output speed but won't allow overstrike on certain characters.

Setting the Tone

To help me decide which characters to choose for the substitution arrays, I wrote a simple program (though it's not included here) that took the character set as a dot matrix and looked at all overstruck combinations of two characters. The following algorithm was used to determine the resulting intensity from each combination:

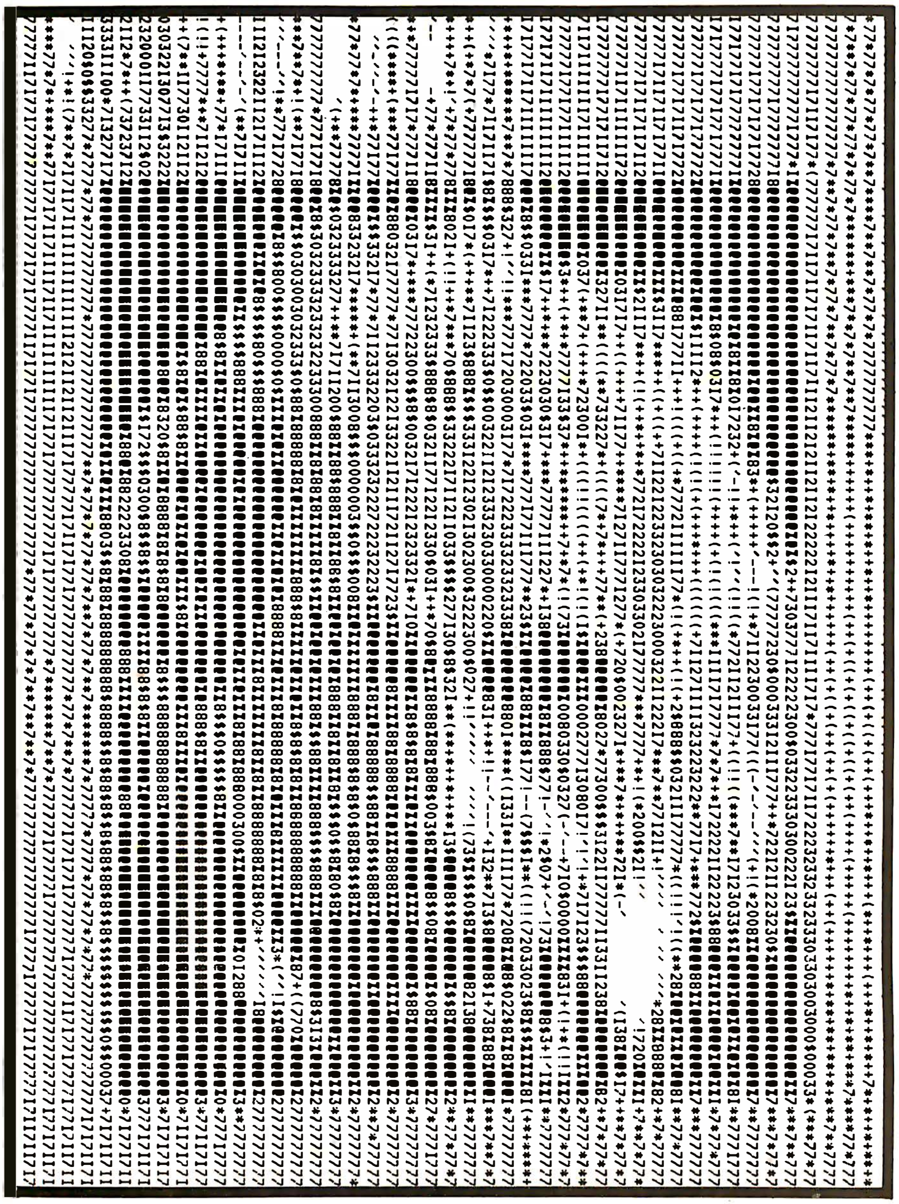
$$I(i,j,k,l)=RCI*[P(i,j,k)+\{S(i,j,l)-RCI*P(i,j,k)\}]$$
$$INTENSITY(k,l)=\text{sum } I(i,j,k,l),\ i=1 \text{ to } n,\ j=1 \text{ to } m$$

where:

INTENSITY(k,l)= intensity value for character "k" printed over character "l".
P(i,j,k)= primary character number "k", row "i", and column "j".
=0, if this dot is not printed.
=1, if this dot is printed.
S(i,j,l)= secondary character number "l", row "i", and column "j".
=0, if this dot is not printed.
=1, if this dot is printed.
RCI= ribbon condition index (range from 0.0 to 1.0).
n= number of rows for character matrix.
m= number of columns for character matrix.

Using this method, I checked all combinations of two characters and made a list ranging from maximum to minimum darkness. (There were 4560 in all.) The resulting intensities ranged from 0 (a space over a space) to 27 (a # on an @). To account for the results of typing one dot on top of another, an RBI (ribbon-condition index) was used. It works like this: for a new ribbon (RBI=1.0), two superimposed dots are not blacker than one dot. However, for an older ribbon (RBI<1.0), the second dot will result in a darker intensity. A value of 0.75 for RBI seems about right for a normal ribbon. The characters I use for the Teletype 43 are shown in table 2. Note that the quotes (") at the ends are used here as delimiters and should not be typed in.

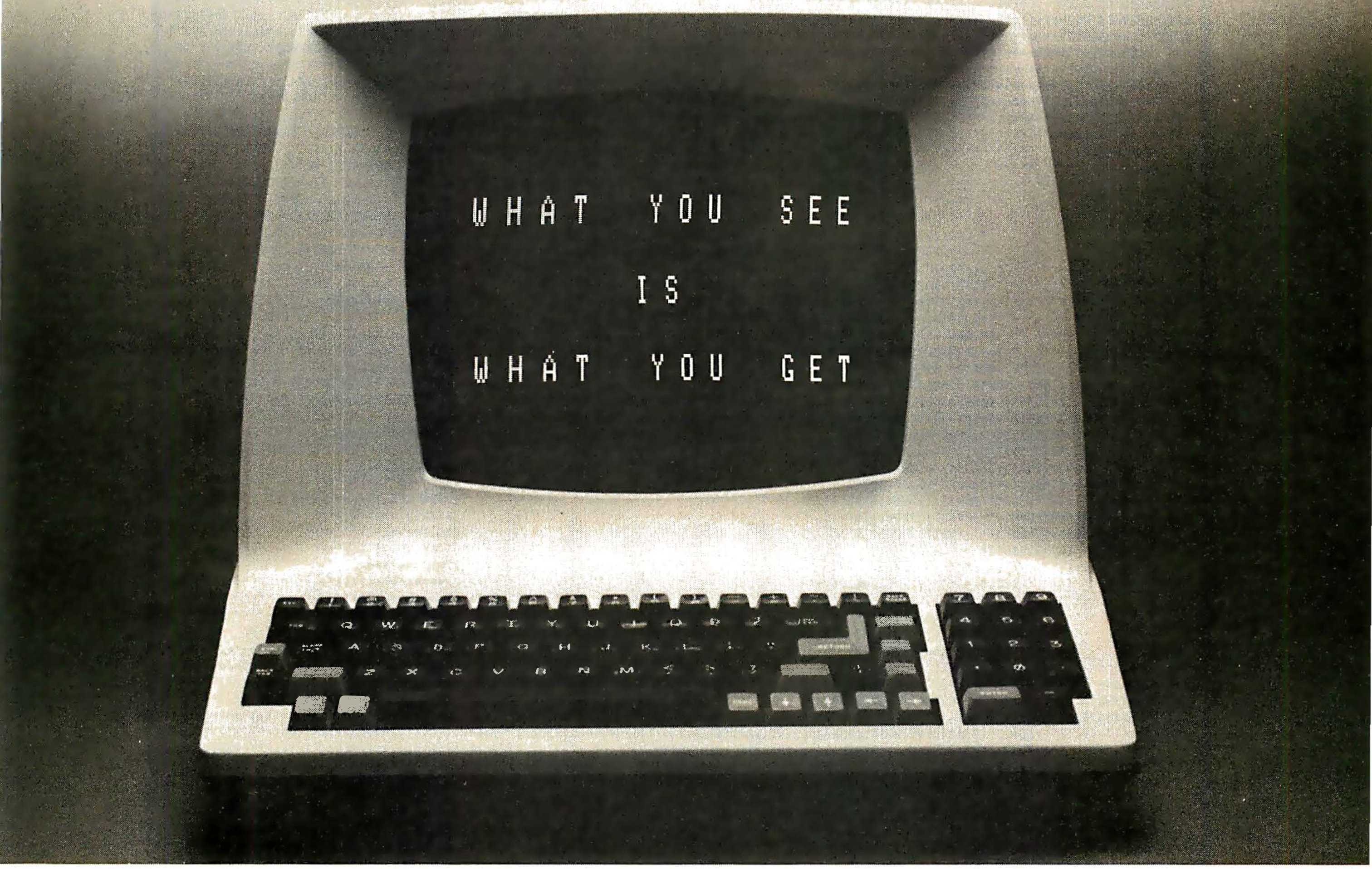
If your printer does not use a dot-matrix system, there are other ways to objectively judge character combinations. Write a simple BASIC program to print out a character combination and then position the phototransistor over this and read the result with the A/D converter. Or, of course, you could just guess. The characters listed in table 2 would be a reasonable place to start. Experimentation is the way to find the best character-substitution array for your own printer.



Recognition of Images

Pictures generated by this system are easier to recognize if they are "blurred" by moving the paper or your head rapidly, by squinting, or by viewing the object from a distance. This has the effect of reducing the geometric distortion caused by the sudden change in contrast from one character to the next. Such blurring can be automated. A simple procedure would be to select the intensity value at a given point by averaging the points around it. This average value is then used when

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selecting an appropriate character to print. Different amounts of blurring can be simulated by using more or fewer points in the averaging process. Obviously, the current program would have to be modified to accomplish this.

Area for Further Investigation

Due to the digital form of the data, an area that would be interesting to look into is *anamorphic* art. This term refers to pictures that are greatly distorted (usually by some geometric procedure) and the original contents are difficult to recognize without transforming the image back by an appropriate means (like curved mirrors). A description and analysis of anamorphic art is contained in Martin Gardner's "Mathematical Games" noted in the references. Because the images are in digital form, transformation becomes a mathematical problem and not an artistic one. I am sure that many enthusiastic hobbyists can produce fascinating pictures along these lines.

Running Under Another Operating System

This program can be modified to run under most operating systems, in-

cluding cassette-tape systems, if the necessary system routines are provided. The calling sequence for all CP/M functions is to specify the desired function by using the C register, loading any arguments using the DE register pair, and calling location 0005 (hexadecimal). Function results are returned in register A. The functions used by IMAGE are:

- Function 1: Read a character from the keyboard. This routine will return a character (with bit 7 cleared) in the A register. If a character is not ready, it waits until it is.
- Function 5: Print a character on the list device. The contents of the E register are sent to the printer.
- Function 9: Print a message. The ASCII (American Standard Code for Information Interchange) character string pointed to by DE will be sent to the console device. A dollar sign ($) terminates the message.
- Function 10: Buffered input. The register pair DE points to a character buffer that will contain a line typed by the user. The first byte must contain the maximum number of characters to be read; the second byte will be set to the actual number read (less the carriage return). The following space will be used to store the input characters (bit 7 cleared).
- Function 11: Interrogate console status. This checks the status of the keyboard. If a character is ready to input (by function 1), the A register will be set to hexadecimal FF. Otherwise the A register is cleared.
- Function 15: Open a file. For this call, DE points to a FCB (file control block) describing the file that will be opened. The program uses the default FCB built by the initial command processor within CP/M. The file is opened for either reading or writing unless the A register contains hexadecimal FF, indicating that the file was not present.
- Function 16: Close a file. Pointing DE at the FCB for the desired file will cause it to be closed. All I/O (input/output) must be completed. The directory will be updated.
- Function 20: Read the next record. The next 128-byte record will be read from the file (DE points to the proper FCB). The data will be read into a buffer whose address is set with function 26. On return, A will contain a 0 (if the transfer went properly) or a 1 (if the end of the file was reached).
- Function 21: Write the next record. The FCB pointed to by register pair DE indicates from which file the 128 bytes are taken. The address of the data must be set by function 26. On return, the A register should contain 0; anything else is interpreted by IMAGE as an out-of-space error.
- Function 26: Set the DMA (direct memory access) address. The next disk read or write will reference data at the address specified by register pair DE. If this is never called, hexadecimal 0080 will be assumed by default.

So there's my system. It's simple, inexpensive, and leaves enough room for your creative modifications such as manipulating blurriness, shadows, outlines, overstrikes, etc. The possibilities are myriad—how about using colored ribbons on your printer to obtain different overstrike hues? Whatever modifications you design, enjoyment is guaranteed. ■

References

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4. Harmon L D. "The Recognition of Faces." *Scientific American*, Volume 220, Number 5, November 1973, pages 70 thru 87.
5. Hale J A G. "Dot Modulation for the Production of Pseudo Grey Pictures." *Proceedings of the SID*, Volume 17, Number 2, Second Quarter 1976, pages 63 thru 74.
6. McDonough T. "Computer Graphics With the Diablo." *Creative Computing*, Volume 5, Number 6, June 1979, pages 32 thru 35.

For those readers who do not care to type in a program as long as the one in listing 1, the author is willing to provide source code on a floppy disk for $10. The disks will be IBM soft-sectored format, written in single density, and will be compatible with CP/M versions 1.4 and 2.0. Contact:

Clark A Calkins
2564 Walnut Blvd #106
Walnut Creek CA 94598

Please allow 1 to 2 weeks for UPS delivery.

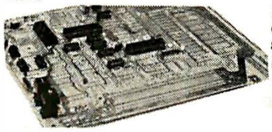
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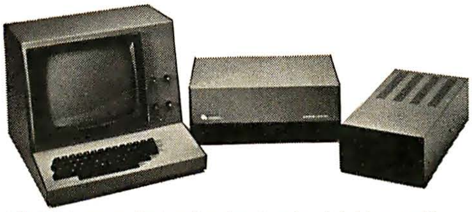
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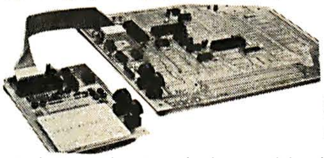
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Level "A" is a complete operating system, perfect for beginners, hobbyists, industrial controller use. $129.95



Full 8" disk system for less than the price of a mini (shown with Netronics Explorer/85 computer and new terminal). System features floppy drive from Control Data Corp., world's largest maker of memory storage systems (not a hobby brand!)



Level "A" With Hex Keypad/Display.

LEVEL "A" SPECIFICATIONS

Explorer/85's Level "A" system features the advanced Intel 8085 cpu, an 8355 ROM with 2k deluxe monitor/operating system, and an advanced 8155 RAM I/O . . . all on a single motherboard with room for RAM/ROM/PROM/EPROM and S-100 expansion, plus generous prototyping space.

PC Board: Glass epoxy, plated through holes with solder mask. • **I/O:** Provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader . . . cassette tape recorder input and output . . . cassette tape control output . . . LED output indicator on SOD (serial output) line . . . printer interface (less drivers) . . . total of four 8-bit plus one 6-bit I/O ports. • **Crystal Frequency:** 6.144 MHz. • **Control Switches:** Reset and user (RST 7.5) interrupt . . . additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard. • **Counter/Timer:** Programmable, 14-bit binary. • **System RAM:** 256 bytes located at F800, ideal for smaller systems and for use as an isolated stack area in expanded systems . . . RAM expandable to 64K via S-100 bus or 4k on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at F000, leaving 0000 free for user RAM/ROM. Features include tape load with labeling . . . examine/change contents of memory . . . insert data . . . warm start . . . examine and change all registers . . . single step with register display at each break point, a debugging/training feature . . . go to execution address . . . move blocks of memory from one location to another . . . fill blocks of memory with a constant . . . display blocks of memory . . . automatic baud rate selection to 9600 baud . . . variable display line length control (1-255 characters/line) . . . channelized I/O monitor routine with 8-bit parallel output for high-speed printer . . . serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Keypad/Display Version): Tape load with labeling . . . tape dump with labeling . . . examine/change contents of memory . . . insert data . . . warm start . . . examine and change all registers . . . single step with register display at each break point . . . go to execution address. Level "A" in this version makes a perfect controller for industrial applications, and is programmed using the Netronics Hex Keypad/Display. It is low cost, perfect for beginners.

HEX KEYPAD/DISPLAY SPECIFICATIONS

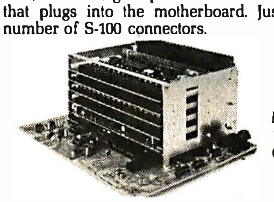
Calculator type keypad with 24 system-defined and 16 user-defined keys. Six digit calculator-type display, that displays full address plus data as well as register and status information.

LEVEL "B" SPECIFICATIONS

Level "B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards, and includes: address decoding for onboard 4k RAM expansion selectable in 4k blocks . . . address decoding for onboard 8k EPROM expansion selectable in 8k blocks . . . address and data bus drivers for onboard expansion . . . wait state generator (jumper selectable), to allow the use of slower memories . . . two separate 5 volt regulators.

LEVEL "C" SPECIFICATIONS

Level "C" expands Explorer/85's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and card are neatly contained inside Explorer's deluxe steel cabinet. Level "C" includes a sheet metal superstructure, a 5-card, gold plated S-100 extension PC board that plugs into the motherboard. Just add required number of S-100 connectors.



Explorer/85 With Level "C" Card Cage.

LEVEL "D" SPECIFICATIONS

Level "D" provides 4k of RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from 0000 to EFFF in 4k blocks.

LEVEL "E" SPECIFICATIONS

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for 2k x 8 RAM IC's (allowing for up to 12k of onboard RAM).

DISK DRIVE SPECIFICATIONS

- 8" CONTROL DATA CORP. professional drive.
- LSI controller.
- Write protect.
- Single or double density.
- Data capacity: 401,016 bytes (SD), 802,032 bytes (DD), unformatted.
- Access time: 25ms (one track).

DISK CONTROLLER/ I/O BOARD SPECIFICATIONS

- Controls up to four 8" drives.
- 1771A LSI (SD) floppy disk controller.
- Onboard data separator (IBM compatible).
- 2 Serial I/O ports
- Autoboot to disk system when system reset.
- 2716 PROM socket included for use in custom applications.
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- Deluxe steel cabinet with individual power supply for maximum reliability and stability.

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- ☐ **8k Microsoft BASIC in ROM kit** (requires Levels "B", "D" and "E") . . . **$99.95** plus $2 post. & insur.
- ☐ **Level "B" (S-100) kit** . . . **$49.95** plus $2 post. & insur.
- ☐ **Level "C" (S-100 6-card expander) kit** . . . **$39.95** plus $2 post. & insur.
- ☐ **Level "D" (4k RAM) kit** . . . **$69.95** plus $2 post. & insur.
- ☐ **Level "E" (EPROM/ROM) kit** . . . **$5.95** plus 50¢ p&h.
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  - ☐ Fan For Cabinet . . . **$15.00** plus $1.50 post. & insur.
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- ☐ **64k RAM kit** . . . **$499.95** plus $2 post. & insur.
- ☐ **16k RAM Expansion kit** (to expand any of the above in 16k blocks up to 64k) . . . **$99.95** plus $2 post. & insur. each.
- ☐ **Intel 8085 cpu Users' Manual** . . . **$7.50** postpaid.
- ☐ **12" Video Monitor** (10MHz bandwidth) . . . **$139.95** plus $5 post. & insur.
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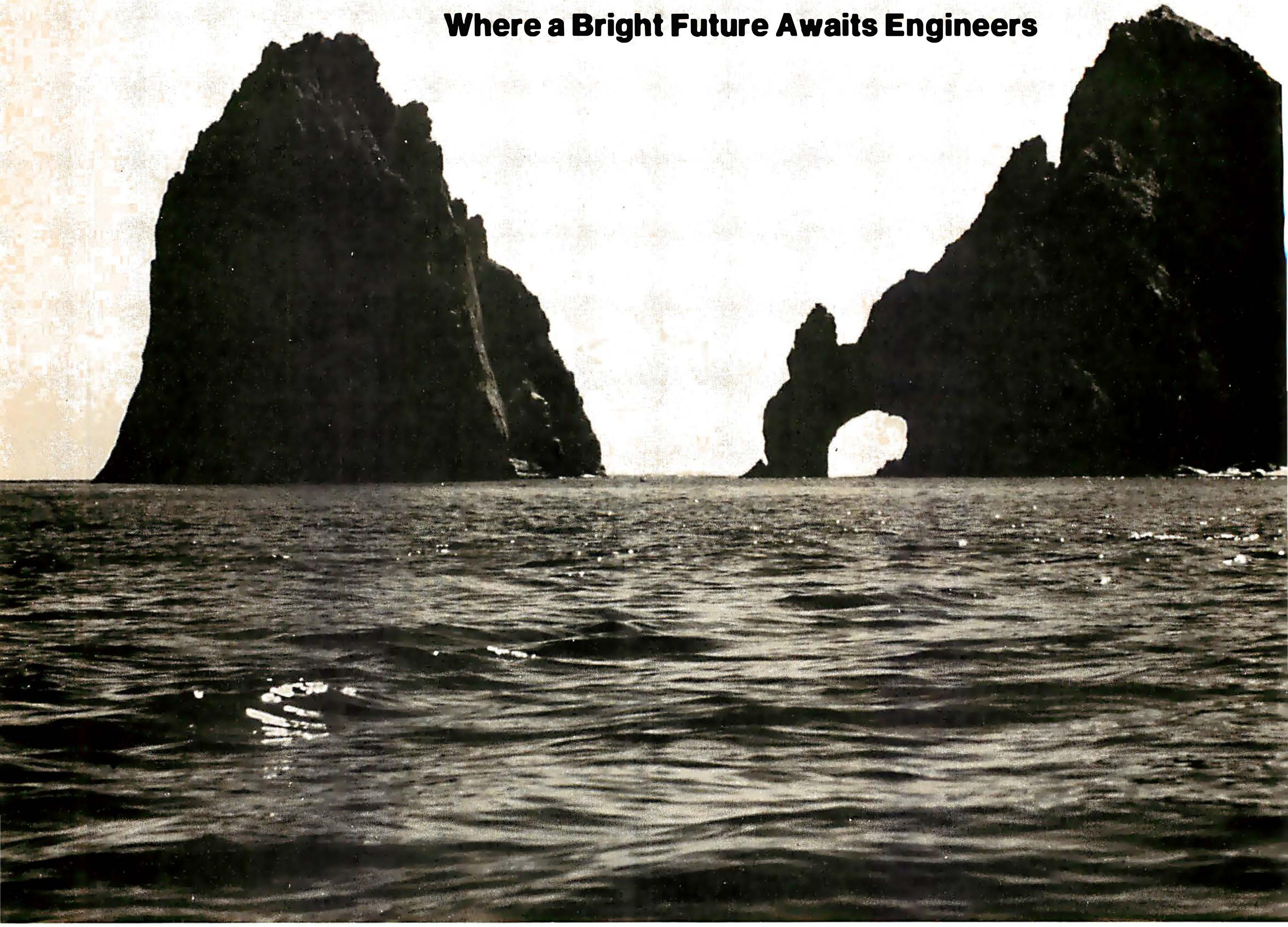
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Southern California

Where a Bright Future Awaits Engineers



Southern California—a mecca for engineers—is rallying in anticipation of a booming business economy because of increased military spending expected under the new Reagan administration. The result is that the demand for electrical/electronic, computer science, data communications or aerospace/aeronautical engineers in the Golden Gate State has never been better.

As one engineer working in Southern California recently remarked, "If an engineer doesn't like the job, he or she can literally walk across the street to another one."

The hub of Southern California's aerospace activity is located in Los Angeles County, Orange County, and San Diego County, areas which in 1980 utilized the talents of 55,859 engineers. This year, according to economists, an additional 15,040 will be required by the high-technology companies that need them.

With 40% of the total aerospace population employment in the United States located in Southern California, New England, another high technology area, runs a distant second, providing 14% of the nation's aerospace engineering employment. Southern California will continue to outshine the rest of the nation in this industry during the 1980s because of two reasons:

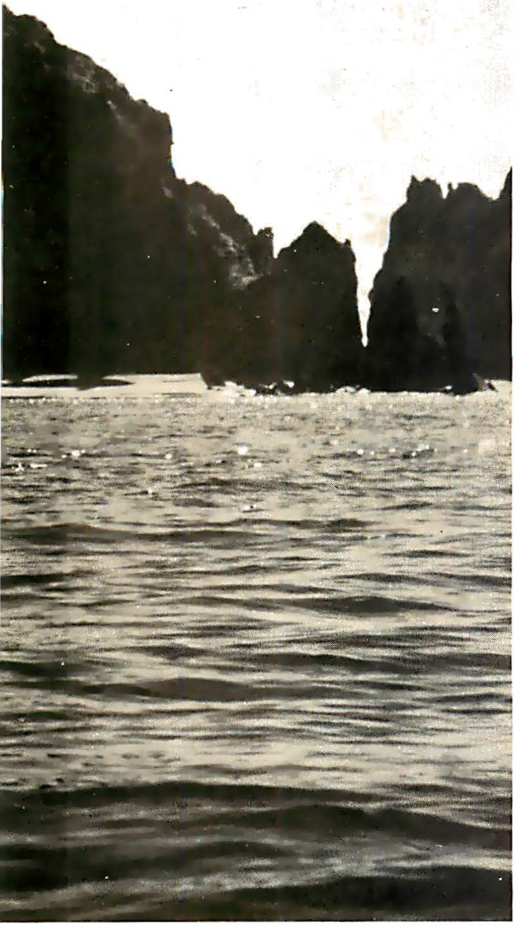
1. The projected spurt in defense spending by the Reagan administration.

2. The construction of commercial, fuel-efficient jet aircraft that will be sold here and abroad.

A spokesman for a major aircraft manufacturer says, "There's talk of a new military bomber, either the B-1 or another one. There is even the possibility that the MX missle program may be sited for our state, and that the cruise missile program will be accelerated. The Polaris, a submarine-launched missile, may also be built here."

Another engineer at the plant of a major aircraft manufacturer confided, "Because Reagan is homegrown, we hope he'll let us build the B-1 bomber here." He added that in addition to the need for aerospace engineers, there are also great opportunities for those interested in alternative energy sources.

The reason is that tax credits of 25% to 50% are awarded to anyone who installs solar heating. Approximately 100,000 solar-heated



homes and businesses exist in the Golden Gate State. Obviously Southern California is a hot market for this field, which is growing in importance.

The computer business is also booming, and companies are scouring the country seeking engineers with the qualifications necessary to develop the high technology products we need for tomorrow.

In addition to the progressive scientific climate, the weather in Southern California is "the closest thing to perfect," according to the United States Weather Bureau. The average temperature is a sunny 71 degrees, with only 14 inches of rain a year, falling mostly between November and March. ("It never rains in Southern California," so the song goes.) The proximity of the ocean, the desert, and the mountains makes it possible to ski, bask in the desert sun, and swim in the Pacific ocean, all in the same day.

Southern California's standard of living is one of the highest in the nation: the median family income in Orange County in 1980, for example, was $29,000. Los Angeles families averaged $26,000, Santa Barbara, $27,000, and San Diego households took home $24,000. But the Catch-22 on housing is that the median price was a whopping $100,000, and this substantial rate is exacerbated (if not caused) by a housing shortage and high interest rates. Businesses employing engineers are, in some instances, trying to circumvent this problem by paying part of the interest rate on the mortgages of employees that relocate. For example, if the mortgage rate is 14%, the company may pay 4% of the cost.

To help ease the housing problem, business-oriented Lieutenant Governor Michael Curb has assembled a task force of real estate, government, and labor officials. He blames rent control for the shortage because he says it discourages construction of new housing.

"If we could increase the supply of houses, demand would diminish, and so would prices," an aide says. He adds, "Average personal income in the state is the highest in the country; it's $9,900 compared with a national average of $8,700. Housing is the only major stumbling block to an otherwise excellent quality of life."

He concludes, "Today business is no longer a dirty word. It's a four letter word meaning jobs."

This statement is borne out by recent figures that show that California will continue to grow at a rate of 30% to 50% through the mid-'80s. Economists in the state predict that there will be 300,000 new jobs needed for manufacturing in the next few years, a sure sign of the state's vibrant economy.

Another advantage of living and working in Southern California is that it offers engineers the opportunity to continue their education. The University of California at San Diego, for example, boasts three Nobel Prize winners on its staff and 36 members of the National Academy of Sciences.

California Institute of Technology in Pasadena is another first-rate school for engineers.

In addition, many of the high technology companies in Southern California offer their employees in-house courses. In some cases engineers are updated in their specialties through the use of closed-circuit television beamed from schools in other parts of the state.



California's Lt. Governor, Mike Curb, is working with a task force of real estate, government, and labor officials to help ease the housing problem.

Most companies encourage their engineer employees to upgrade their skills, and many pay full or partial tuition.

To sum up, the demand for engineers in beautiful Southern California in this decade is expected to remain strong. The salaries are high, the work is both exciting and important, and industry is hiring at an accelerated rate. In addition, the Golden Gate State offers a lifestyle with every kind of cultural and recreational activity available anywhere in the world.

As one Southern California economist put it, "Where are all those engineers? We need them."

If you are a recent graduate or a veteran engineer seeking a virtually unlimited future, the Golden Gate State offers an opportunity that you may never have again. If you are serious about your career, are an electrical/electronic, computer science, data communications, or an aerospace/aeronautical engineer, don't miss the following Southern California Career Opportunities Section featuring blue-chip companies that are interested in you and your talents now and in the future.

—John Brand

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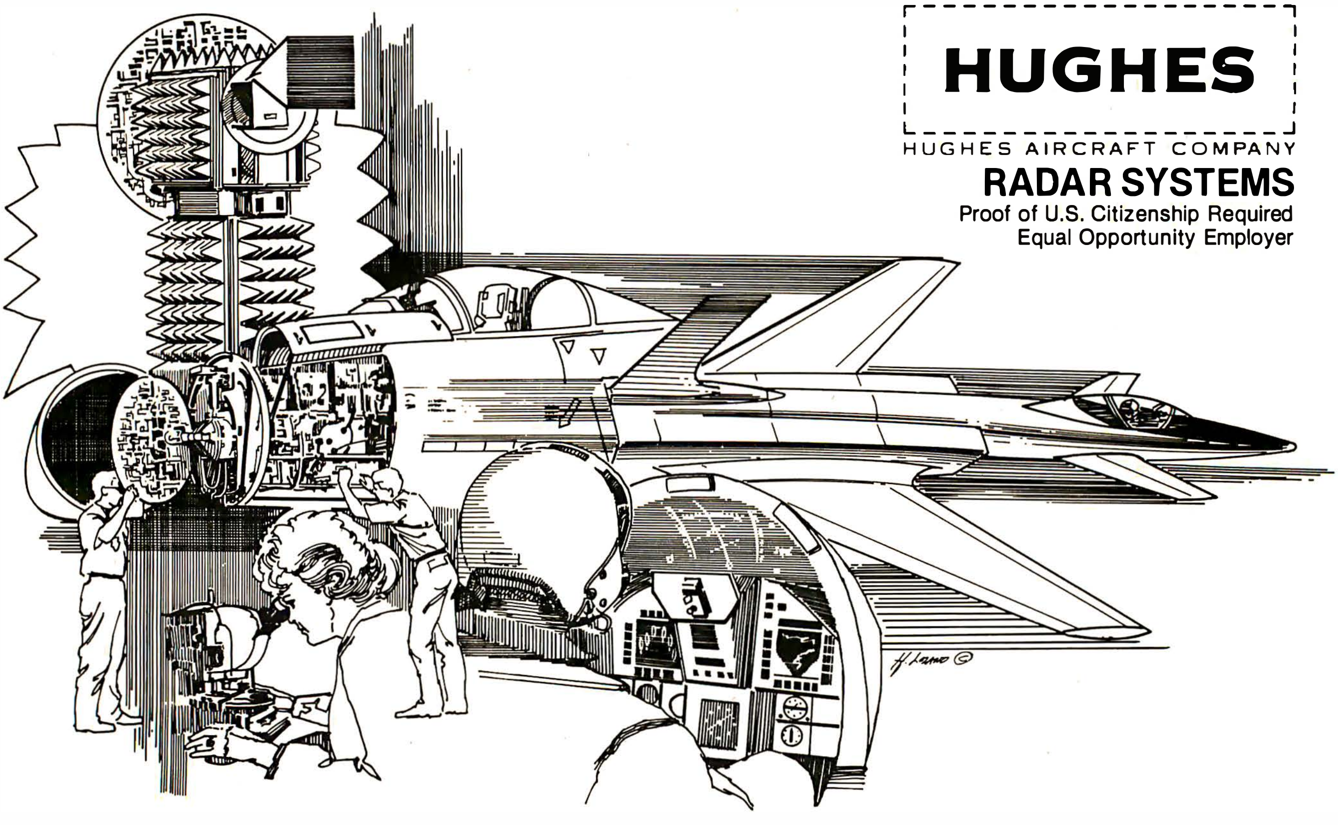
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The Heath H-14 Printer

Bradford E Rehm, 1004 Middle Cove Dr, Plano TX 75023

What this country needs is a good $250 printer. It ought to accept characters at 9600 bps (bits per second) and print them at 100 lines per minute. It should produce letter-quality print in various formats, including 80, 96, and 132 columns per page and 6, 8, or 10 lines per inch. It should have graphics capabilities, and it should offer an adjustable tractor-feed mechanism that can use narrow or wide paper. It should be very reliable, easy to service, quiet, and pleasing to look at.

Has Heath given us the All-American line printer? Perhaps not, but the folks in Benton Harbor, Michigan, have chalked up real accomplishments in several areas. As a $595 kit, the H-14 comes closer than any other 80-column impact printer on the market (at this writing) to meeting the price criterion. The somewhat higher "assembled" price still falls below most of its competitors' prices. And the H-14 does this while making a fine showing in the area of capabilities.

The H-14 Kit

The kit version of the printer is somewhat intimidating because of the sheer number of parts that emerge from the shipping carton. Rumors have been circulating to the effect that Heath had simply built electronics around an imported printer mechanism or that they had built a new enclosure around a familiar American-made mechanism which uses the Practical Automation dot-matrix print head. The truth is that while Heath uses the Practical Automation DM-101 print head, the rest of the mechanism (except, of course, for the driver motors) is of Heath's own design.

The builder, at any rate, assembles the printer mechanism from the very beginning. Happily, it is surprising to discover how easy the assembly is to execute, because, as always, Heath has done an outstanding job of preparing the kit manual. In fact, it is hard to believe that Heath charges $300 more for the assembled version.

There are few special parts in the mechanical portion of the printer. Two of the four shafts that operate the sprocket feed and support the print head, for example, are standard, quarter-inch extension shafts. This allows use of common quarter-inch bushings, collars, and grommets, which not only contributes to the low cost of the device, but also makes maintenance simpler.

Heath chose a more expensive route in providing a substantial die-cast metal base upon which the printer is built. It forms the lower half of the housing and supports the print-head mechanism, power transformer, and printed-circuit board. Although the molded plastic cover of the device is very light (why not, since it supports nothing), the metal base gives the H-14 the hefty, stay-put feel of a heavy-duty piece of equipment.

The Electronic Circuitry

Nearly all of the parts in the electronics portion of the H-14 are mounted on two printed-circuit boards. The main board is busy but by no means crowded, and there are two extra LEDs (light-emitting diodes) available for checking logic functions as the integrated circuits are installed. The second, smaller board, which corrects a design oversight and which was not initially shipped with the kit (original shipment, February 1979), is mounted adjacent to the paper-drive motor.

The circuit is assembled on a double-sided, 12.5 by 25.5 cm (4¾ by 10⅛ inch) board which includes the power-supply rectifier diodes, the printer-data-handling electronics, and the print-head and motor-driver circuits. The power-supply filters, a low-voltage regulator and a series-pass transistor, and an end-of-paper sensor are mounted off the board.

Because a microprocessor-controller is used, the circuitry is straightforward. Data enters and leaves the printer through a pair of EIA or 20 mA current-loop interfaces. These are connected to a UART (universal asynchronous receiver/transmitter) that provides the inter-

At a Glance

Name
H-14

Manufacturer
Heath Company
Benton Harbor MI
49022, (800) 253-0570

Dimensions
Height: 12.2 cm (4¾ inches); Width: 46.5 cm (18⅜ inches); Depth: 36.2 cm (14¹³⁄₁₆ inches)

Price
$595 kit; $895 assembled

Features
Controlled by Fairchild F8 microprocessor; uses Practical Automation DM-101 print head (5 by 7 dot-matrix, impact); ASCII 96-character set; 75 cps maximum print speed (40 cps average); 80-, 96-, or 132-column line width, software selectable; accepts 2½- to 9½-inch-wide paper, fan-folded sprocket-feed only

Software
Requires H-8-14, H-8-17, or H-8-18 software for use with Heath H-8 computer or HT-11 software for use with Heath H-11A computer

Hardware Options
Serial interface via RS-232 or 20 mA current loop, 110 to 4800 bps

face between the serial communication lines and the parallel data bus of the microprocessor. The latter is a descendant of Fairchild's F8 family and includes on-chip read-only memory. This custom-masked device holds the program which enables the microprocessor to operate the printer. Data storage and address latching (which helps the processor interleave I/O [input/output] and printing tasks) are handled by a pair of 2112 memory devices and a 74LS273 8-bit latch. The processor also has four 8-bit I/O ports which are used as follows: two drive the seven print-head solenoids, the head-drive motor, the ribbon-drive motor, and the paper-drive stepper motor; another does I/O to the UART; and the remaining one selects the specific device which is being driven.

Two Interesting Circuit Details

Two other sections of the circuit merit attention. Asked about how Heath was able to make the Practical Automation print head operate at speeds in excess of 120 cps (characters per second) while other printers using the same head have been restricted to lower speeds, an engineer at Heath explained that the H-14 continually monitors the resistance of one of the head magnet coils. In light-duty printing, the coil temperature does not rise significantly. During long printing jobs or when using the compact 132-column print, the internal temperature will rise to the point at which the head could be damaged. The increased temperature also increases the resistance of the winding, however, so a simple bridge circuit, monitored by two op amps, is used to detect the change and briefly halt printing.

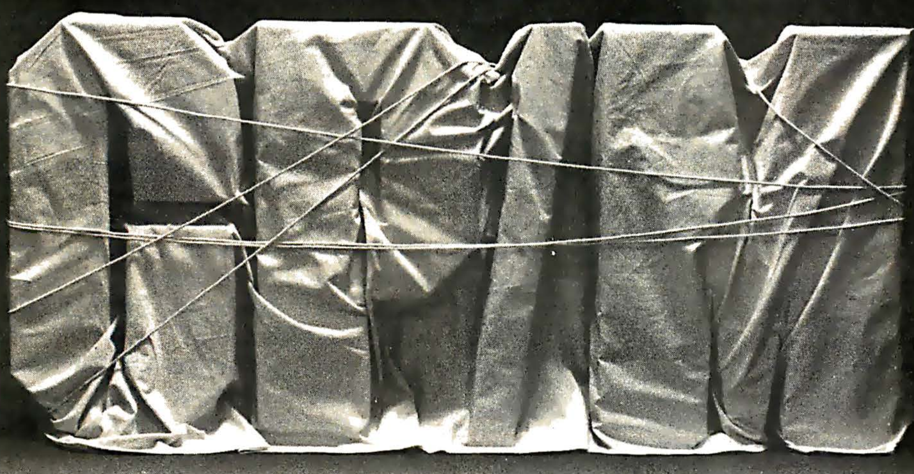
On learning about this trick, one wonders if the printer will spend most of its time cooling down after it reaches operating temperature. In practice, however, this arrangement works well. The H-14 printed eight to fifteen 80-column pages before pausing to cool. The number of pages it executes seems to depend mainly on the ambient air temperature and circulation. Heath has left a slot in the bottom plate to provide cooling air from below, which can exit through the paper-viewing slot in the top cover, so the Heath engineers clearly understand that air circulation affects throughput.

That large rectangular slot in the bottom plate, just below the print head, is surrounded by a row of small holes. Some H-14 owners will visualize a blower and bellows arrangement fastened to the bottom plate at a flange bolted at these holes. It is surprising that they are not there for that reason at all. Although the printer is not certified by the US Underwriters' Laboratories, it has been approved by the latter's Canadian counterpart. The row of holes is necessary so that the H-14 can pass a test in which flaming oil poured into the enclosure must be quenched as it exits from the ventilation slot on the bottom plate. (Isn't it good to know your H-14 can be used as a flaming-oil quencher!)

The number of pages which can be printed before the first cool-down pause is smaller, of course, when the 96- or 132-column print format is selected. The duty cycle of the head is increased in these modes—laying down 96 characters in a line before taking a breath (while going to the next line starting position) is more taxing than printing only 80 characters before taking a line break. Nevertheless, the pauses the H-14 takes for head cooling are not long. Again, the time required depends upon the ambient air temperature, but I find that most pauses are on the

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order of two to five seconds, and they occur, nominally, every two to five lines after an eight- to fifteen-page warm-up period.

How closely does the H-14 approach the thermal limits of the print head in this kind of operation? A call to Practical Automation in Shelton, Connecticut, yielded the information that the DM-101 head can be operated at 100 cps (characters per second) bidirectionally if sufficient forced-air cooling is available. Continuous bidirectional operation above 16.5 cps is not recommended without forced ventilation or other protection, and the maximum internal operating temperature of the head is 62° C.

Heath claims that the temperature threshold for the shutdown has been set at approximately 50° C, which is well within the Practical Automation specification. This suggests that the printer can be run for long periods without fear of overheating the head. If you should want to try this, by the way, you may want to make sure that the head nose bearing has adequate lubrication. There is a felt-pad oil retainer on the back of the unit which should normally be given a few drops of machine oil after running through five boxes of paper. Giving it a drop or two before printing a whole box nonstop would be prudent.

There is no way to directly lubricate the solenoid-operated wires that actually do the printing. As is true for most wire-matrix heads, the wires are continuously lubricated by ink in the ribbon. This means that if you intend to realize the full, 100-million-character life of the H-14's head, you will never want to run the printer with a dry ribbon or without paper. You will also want to use only nylon ribbons, since cloth ribbons are easily perforated by the head wires.

Practical Automation recommends that nylon ribbons containing oil-based ink be used. A Heath representative that I contacted could not confirm that the office-equipment-type ribbon Heath supplies contains an oil-based ink. Testing at Heath has shown, however, that maximum head life is possible with its ribbons. (The manufacturer of one of the leading brands of ribbons available in office-supply stores was also contacted in an attempt to learn whether the ink used in these products is oil-based. In spite of the best efforts of the company's Dallas office, we were not able to acquire the information.)

The other interesting circuit is the driver for the paper-feed motor. There was a note in the original instruction manual for the H-14 saying that Heath would provide, upon request, a modification kit to enable the printer to more reliably lift paper from a box placed on the floor below it. The problem addressed occasionally appeared when my H-14 was required to lift 20-pound paper. The paper-drive stepper motor would occasionally growl and feed the paper in fractional-line increments instead of a full line.

The original stepper drivers used 7416 open-collector inverter/buffer devices to interface the microprocessor port to transistors that switched the motor on and off. One side of each winding was pulled high by a 12 V supply, while the other was pulled low by a transistor. A step was executed by turning off a pair of transistors. The problem was that the motor did not develop enough torque with a 12 V supply, but a higher voltage would probably have overheated it (stepper motors consume

DYNACOMP

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ATARI	**TRS-80 (Level II)***
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GAMES, SIMULATIONS and EDUCATION

BRIDGE 2.0 (Available for all computers) — Price: $17.95 Cassette, $21.95 Diskette

An all-inclusive version of this most popular of card games. This program both BIDS and PLAYS either contract or duplicate bridge. Depending on the contract, your computer opponents will either play the offense OR defense. If you bid too high, the computer will double your contract! BRIDGE 2.0 provides challenging entertainment for advanced players and 'isan excellent learning tool for the bridge novice.

HEARTS 1.5 (Available for all computers) — Price: $14.95 Cassette, $18.95 Diskette

An exciting and entertaining computer version of this popular card game. Hearts is a trick-oriented game in which the purpose is not to take any hearts or the queen of spades. Play against two computer opponents who are armed with hard-to-beat playing strategies.

VALDEZ (Available for all computers) — Price: $14.95 Cassette, $18.95 Diskette

A simulation of supertanker navigation in the Prince William Sound and Valdez Narrows. The program uses an extensive 256X256 element radar map and employs physical models of ship response and tidal patterns. Chart your own course through ship and iceberg traffic. Any standard terminal may be used for display.

FLIGHT SIMULATOR (Available for all computers) — Price: $17.95 Cassette, $21.95 Diskette

A realistic and extensive mathematical simulation of take-off, flight and landing. The program utilizes aerodynamic equations and the characteristics of a real airfoil. You can practice instrument approaches and navigation using radials and compass headings. The more advanced flyer can also perform loops, half-rolls and similar aerobatic maneuvers.

CRIBBAGE 2.0 (TRS-80 only) — Price: $14.95 Cassette, $18.95 Diskette

This is a well-designed and nicely executed two-handed version of the classic card game, cribbage. It is an excellent program for the cribbage player in search of a worthy opponent as well as the beginner wishing to learn the game, in particular the scoring and jargon. The standard cribbage score board is continually shown at the top of the display (utilizing the TRS-80's graphics capabilities), with the cards shown underneath. The computer automatically scores and also announces the points using the traditional phrases.

CHESS MASTER (North Star and TRS-80 only) — Price: $19.95 Cassette, $23.95 Diskette

This complete and very powerful program provides five levels of play. It includes castling, en passant captures and the promotion of pawns. Additionally, the board may be preset before the start of play, permitting the examination of "book" plays. To maximize execution speed, the program is written in assembly language (by SOFTWARE SPECIALISTS of California). Full graphics are employed in the TRS-80 version, and two widths of alphanumeric display are provided to accommodate North Star users.

STARTREK 3.2 (Available for all computers) — Price: $ 9.95 Cassette, $13.95 Diskette

This is the classic Startrek simulation, but with several new features. For example, the Klingons now shoot at the Enterprise without warning while also attacking starbases in other quadrants. The Klingons also attack with both light and heavy cruisers and move when shot at! The situation is hectic when the Enterprise is besieged by three heavy cruisers and a starbase S.O.S. is received! The Klingons get even!

SPACE TILT (Apple only) — Price: $10.95 Cassette, $14.95 Diskette

Use the game paddles to tilt the plane of the TV screen to "roll" a ball into a hole in the screen. Sound s'imple? Not when the hole gets smaller and smaller! A built-in timer allows you to measure your skill against others in this habit-forming action game.

GAMES PACK I and GAMES PACK II — Price: $ 9.95 each, Cassette, $13.95 each, Diskette

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Why pay $5.95 or more per program when you can buy a DYNACOMP collection for just $9.95?

STUD POKER (ATARI only) — Price: $11.95 Cassette, $15.95 Diskette

This is the classic gambler's card game. The computer deals the cards one at a time and you (and the computer) bet on what you see. The computer does not cheat and *usually* bets the odds. However, it sometimes bluffs! Also included is a five card draw poker betting practice program. This package will run on a 16K ATARI. Color, graphics, sound.

NOMINOES JIGSAW (TRS-80 only) — Price: $16.95 Cassette, $20.95 Diskette

NOMINOES JIGSAW is an intriguing and sophisticated graphical puzzle. The jigsaw consists of a 9 by 9 board partially filled with randomly chosen shapes (nominoes), of which there are 60 types. By knowing that the shapes must be legally connected, and by guessing the shape at each location, all the nominoes may be eventually deduced. Scoring is based on the number of guesses required and the difficulty of the board set-up.

MOVING MAZE (Apple only) — Price: $10.95 Cassette, $14.95 Diskette

MOVING MAZE employs the games paddles to direct a puck from one side of a maze to the other. However, the maze is dynamically (and randomly) built and is continually being modified. The objective is to cross the maze without touching (or being hit by) a wall. Scoring is by an elapsed time indicator, and three levels of play are provided.

BLACK HOLE (Apple only) — Price: $14.95 Cassette, $18.95 Diskette

This is an exciting graphical simulation of the problems involved in closely observing a black hole with a space probe. The object is to enter and maintain, for a prescribed time, an orbit close to a small black hole. This is to be achieved without coming so near the anomaly that the tidal stress destroys the probe. Control of the craft is realistically simulated using side jets for rotation and main thrusters for acceleration. This program employs Hi-Res graphics and is educational as well as challenging.

TEACHER'S PET I (Available for all computers) — Price: $ 9.95 Cassette, $13.95 Diskette

This is the first of DYNACOMP's educational packages. Primarily intended for pre-school to grade 3, TEACHER'S PET provides the young student with counting practice, letter-word recognition and three levels of math skill exercises.

CRYSTALS (ATARI only) — Price: $ 9.95 Cassette, $13.95 Diskette

A unique algorithm randomly produces fascinating, graphics displays accompany with tones which vary as the patterns are built. No two patterns are the same, and the combined effect of the sound and graphics are mesmerizing. CRYSTALS has been used in local stores to demonstrate the sound and color features of the Atari.

POKER PARTY (Available for all computers) — Price: $17.95 Cassette, $21.95 Diskette

POKER PARTY is a draw poker simulation based on the book, POKER, by Oswald Jacoby. This is the most comprehensive version available for micro computers. The party consists of yourself and six other (computer) players. Each of these players (you will get to know them) has a different personality in the form of a varying propensity to bluff or hold under pressure. Practice with POKER PARTY before going to that expensive game tonite!

Availability

DYNACOMP software is supplied with complete documentation containing clear explanations and examples. All programs will run within 16K program memory space (ATARI requires 24K). Except where noted, programs are available on ATARI, PET, TRS-80 (Level II) and Apple (Applesoft) cassette and diskette as well as North Star single density (double density compatible) diskette. Additionally, most programs can be obtained on standard (IBM format) 8" CP/M floppydisks for systems running under MBASIC.

[+] *ATARI, PET, APPLE II, TRS-80, NORTH STAR, CP/M and IBM are registered trade names and/or trademarks.*

Circle 173 on inquiry card.

BUSINESS, UTILITIES and MISCELLANEOUS

MAIL LIST II (North Star only) — Price: $21.95

This many-featured program now includes full alphabetic and zip code sorting as well as file merging. Entries can be retrieved by user-defined code, client name or Zip Code. The printout fo nat allows the use of standard size address labels. Each diskette can store more than 1100 entries (single density; over 2200 with double density systems)!

TEXT EDITOR I (Letter Writer) — Price: $14.95 Cassette, $18.95 Diskette

An easy to use, line-oriented text editor which provides variable line widths and simple paragraph indexing. This text editor is ideally suited for composing letters and is quite capable of handling much larger jobs. Available for all computers.

PERSONAL FINANCE SYSTEM (ATARI only) — Price: $34.95 Diskette

PFS is a single disk menu oriented system composed of 10 programs designed to organ'ize and simplify your personal finances. Features include a 300 transaction capacity; fast access; 26 optional user codes; data retrieval by month, code or payee; optional printing of reports; checkbook balancing; bar graph plotting and more. Also provides on the diskette is ATARI DOS 2.

FINDIT (North Star only) — Price: $19.95

This is a three-in-one program which maintains information accessible by keywords of three types: Personal (eg: last name), Commercial (eg: plumbers) and Reference (eg: magazine articles, record albums, etc). In addition to keyword searches, there are birthday, anniversary and appo'intment searches for the personal records and appointment searches for the commercial records. Reference records are accessed by a single keyword or by cross-referencing two or three keywords.

DFILE (North Star only) — Price: $19.95

This handy program allows North Star users to maintain a specialized data base of all files and programs in the stack of disks which invariably accumulates. DFILE is easy to set up and use. It will organize your disks to provide efficient locating of the desired file or program.

COMPARE (North Star only) — Price: $12.95

COMPARE is a single disk utility software package which compares two BASIC programs and d'isplays the file sizes of the programs in bytes, the lengths in terms of the number of statement lines, and the line numbers at which various listed differences occur. COMPARE permits the user to examine versions of his software to verify which are the more current, and to clearly identify the changes made during development.

COMPRESS (North Star only) — Price: $12.95

COMPRESS is a single-disk utility program which removes all unnecessary spaces and (optionally) REMark statements from North Star BASIC programs. The source file is processed one line at a time, thus permitting very large programs to be compressed using only a small amount of computer memory. File compressions of 20-50% are commonly achieved.

GRAFIX (TRS-80 only) — Price: $12.95 Cassette, $16.95 Diskette

This unique program allows you to easily create graphics directly from the keyboard. You "draw" your figure using the program's extensive cursor controls. Once the figure is made, it is automatically appended to your BASIC program as a string variable. Draw a "happy face", call it H$ and then print it from your program using PRINT H$! This is a very easy way to create and save graphics.

TIDY (TRS-80 only) — Price: $10.95 Cassette, $14.95 Diskette

TIDY is an assembly language program which allows you to renumber the lines in your BASIC programs. TIDY also removes unnecessary spaces and REMark statements. The result is a compacted BASIC program which uses much less memory space and executes significantly faster. Once loaded, TIDY remains in memory; you may load any number of BASIC programs without having to reload TIDY!

NORTH STAR SOFTWARE EXCHANGE (NSSE) LIBRARY — Price $9.95 Diskette

DYNACOMP now distributes the 20+ volume NSSE library. Most of these diskettes offer an outstanding value for the purchase price. Write for details regarding the contents of this library and quantity (four or more) purchases.

STATISTICS and ENGINEERING

DATA SMOOTHER (Not available for ATARI) — Price: $14.95 Cassette, $18.95 Diskette

This special data smoothing program may be used to rapidly derive useful information from noisy business and engineer'ing data which are equally spaced. The software features choice in degree and range of fit, as well as smoothed first and second derivative calculation. Also included 'isautomatic plotting of the input data and smoothed results.

FOURIER ANALYZER (Available for all computers) — Price: $14.95 Cassette, $18.95 Diskette

Use this program to examine the frequency spectra of limited duration signals. The program features automatic scaling and plotting of the input data and results. Practical applications include the analysis of complicated patterns in such fields as electronics, communications and business.

TFA (Transfer Function Analyzer) — Price: $19.95 Cassette, $23.95 Diskette

This is a special software package which may be used to evaluate the transfer functions of systems such as hi-fi amplifiers and filters by examining their response to pulsed inputs. TFA is a major modification of FOURIER ANALYZER and contains an engineering-oriented decibel versus log-frequency plot as well as data editing features. Whereas FOURIER ANALYZER is designed for educational and scientific use, TFA is an engineering tool. Available for all computers.

HARMONIC ANALYZER (Available for all computers) — Price: $24.95 Cassette, $28.95 Diskette

HARMONIC ANALYZER was designed for the spectrum analysis of repetitive waveforms. Features include data file generation, editing and storage/retrieval as well as data and spectrum plotting. One particularly unique facility is that the input data need not be equally spaced or in order. The original data is sorted and a cubic spline interpolation is used to create the data file required by the FFT algorithm.

FOURIER ANALYZER, TFA and HARMONIC ANALZYER may be pruchased together for a combined price of $44.95 (three cassettes) and $56.95 (three diskettes).

REGRESSION I (Available for all computers) — Price: $19.95 Cassette, $23.95 Diskette

REGRESSION I is a unique and exceptionally versatile one-dimensional least squares "polynomial" curve fitting program. Features include very high accuracy; an automatic degree determination option; an extensive internal library of fitting functions; data editing; automatic data and curve plotting; a statistical analysis (eg: standard deviation, correlation coefficient, etc.) and much more. In addition, new fits may be tried without reentering the data. REGRESSION I is certa'inly the cornerstone program in any data analysis software library.

REGRESSION II (PARAFIT) (Available for all computers) — Price: $19.95 Cassette, $23.95 Diskette

PARAFIT is designed to handle those cases in which the parameters are imbedded (possibly nonlinearly) in the fitting function. The user simply inserts the functional form, including the parameters (A(1), A(2), etc.) as one or more BASIC statement lines. Data and results may be manipulated and plotted as with REGRESSION I. Use REGRESSION I for polynomial fitting, and PARAFIT for those complicated functions.

REGRESSION I and II may be purchased together for $36.95 (cassettes) and $44.95 (diskettes)

BASIC SCIENTIFIC SUBROUTINES, Volume 1 (Not available for ATARI)

DYNACOMP is the exclusive distributor for the software keyed to the text *BASIC Scientific Subroutines, Volume I* by F. Ruckdeschel (see the BYTE/McGraw-Hill advertisement in BYTE magazine, January 1981). These subroutines have been assembled according to chapter. Included with each collection is a menu program which selects and demonstrates each subroutine.

Collection #1: Chapters 2 and 3: Data and function plotting, complex variables
Collection #2: Chapter 4: Matrix and vector operations
Collection #3: Chapters 5 and 6: Random number generators, series approximations

Price per collection: $14.95 Cassette
$18.95 Diskette

All three collections are available for $39.95 (three cassettes) and $49.95 (three diskettes).

Because the text is a vital part of the documentation, *BASIC Scientific Subroutines, Volume I* is available from DYNACOMP for $19.95 plus 75¢ postage and handling.

Ordering Information

All orders are processed and shipped postpaid within 48 hours. Please enclose payment with order along with computer information. If paying by VISA or Master Card, include all numbers on card. For orders outside North America add 10% for ship-p'ingand handling.

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power even while they are not in motion). The solution required removing the motor-driver transistors from the main circuit board and adding a piggyback board at the motor.

The new circuit uses three 7486 two-input exclusive-OR gates and a flip-flop to determine whether the circuit is in the *step* or the *hold* mode. A diode and a pass transistor are added to determine whether 12 V or 35 V DC will be applied to the motor windings. The rest of the circuit is similar to the original, except for the addition of another set of inverter/drivers, which are necessary because the wiring to the motor-winding pairs has been reversed. In the hold mode, the diode feeds 12 V to the motor windings, enabling them to hold the feed mechanism at the current line. When a step signal arrives from the processor, the transistor is turned on (by the exclusive-OR gates and the flip-flop) and applies 35 V to the motor. In this way, the higher voltage is available for stepping, when maximum torque is needed. The rest of the time, the motor sees only 12 V, and its average power-dissipation limit is never exceeded.

Once again, Heath assures that this tactic, which coaxes superior performance from a conventional part, will not appreciably shorten its life. Thumb-and-index-finger measurement confirms that the motor does not become appreciably hotter with the new driver than it did with the original one. Apparently, burning the candle at both ends works in this instance.

Configuring the H-14

When the printer has been assembled and tested, it is time to connect it to a computer and do some printing. As with most interfacing tasks, this one requires some planning. Heath chose to include a 256-character buffer in the H-14 so that, for example, a multitasking system could fill the buffer and go off to continue other tasks. To facilitate this kind of operation, the H-14 can accept serial ASCII (American Standard Code for Information Interchange) data at up to 4800 bps (110 to 4800 bps options are selected at a switch in the printer). Handshaking between the printer and the computer system can take place in either of two ways. When the buffer is empty, the H-14 sends an ASCII Control-Q (hexadecimal 11) on the return communication line to its host. When the buffer is full, a Control-S (hexadecimal 13) is transmitted. The computer software can therefore use these characters as signals to start or stop sending data.

The other handshaking option includes having the computer system look at the RTS (Request To Send) line from the printer. When the line buffer is empty, RTS is *on* (low), indicating that there is room for sixteen more characters; when it is full, RTS goes *off*.

I have already mentioned that the H-14 can provide variable line widths and line spacings. The 80-column and 132-column options can be selected by means of a push-button on the front panel. These and all the other options can also be obtained through software commands transmitted in the text. The sequence Escape/u/Control-T, for example, switches the output from 80-column to 96-column format; an Escape/y sets the line spacing to 8; the Form Feed (hexadecimal 0C) executes a carriage return and a form feed. The front panel also has Feed Forward and Feed Reverse buttons which can be used to position the print head at the top of a form, when the printer is switched off-line.

One option which will probably *not* be offered for the

H-14 is an F8 processor with different programming to permit graphics printing. The reason is the lack of program and table space in the processor. Another consideration is that the paper movement is not reversible because of the H-14's rear paper inlet. One is tempted to try to feed the paper through the ventilation slot in the bottom plate of the enclosure—it is in just the right position below the print head and platen. An LED and photodiode are mounted in the normal feed path, however, to detect the out-of-paper condition. If the paper were brought in through the bottom of the cabinet, modifications to a paper guide would have to be made and the paper-detector feature would have to be sacrificed.

The Results

The print output of the H-14 is pleasing to the eye and easy to read, even when the 132-column format is used. The ribbon is canted a few degrees to minimize ink draining caused by the print head's covering the same area of the ribbon in repeated passes across the page. The ribbon can be canted further by shifting washers under its pulley. This gives additional protection from draining.

The spacing between the tractor-feed gears is adjustable, so that they can accept papers from 5.5 to 24.5 cm (2½ to 9½ inches) wide. Although I normally use 24.5 cm (9½-inch) forms which can be burst to a 22 cm (8½-inch) page, I have also used 22 cm multiform paper and 8 cm (3½-inch) wide label forms. The H-14 handles the heavy labels very well, and it easily pulls 20-pound paper from a box on the floor, two feet below the feed inlet.

Is the H-14 the All-American Printer?

A number of new, inexpensive impact printers have entered the market since the H-14 was first advertised in January 1979. IDS, C Itoh, and Anadex are a few of the companies which have produced under-$1000 offerings with a variety of features. A buyer faced with the task of choosing among them will do well to check the performance specifications very closely. The H-14's need for cool-down time after printing ten or fifteen pages could be annoying in an office environment. On the other hand, some of the units that can print continuously may have no thermal overload protection and rely on the office air conditioning to keep things cool. Others have long duty cycles, but do not offer variable page and line widths.

The H-14 is a particularly good choice for the personal-computer user because it not only performs well, but it should be inexpensive to maintain. It accepts a standard B-72 Teletype ribbon that can be purchased at most office supply stores for two or three dollars. If the kit is assembled, the buyer has a working knowledge of the construction of the unit and can probably repair mechanical faults which might develop. The excellent testing and troubleshooting guides included in each of the printer's two manuals cover most electrical problems.

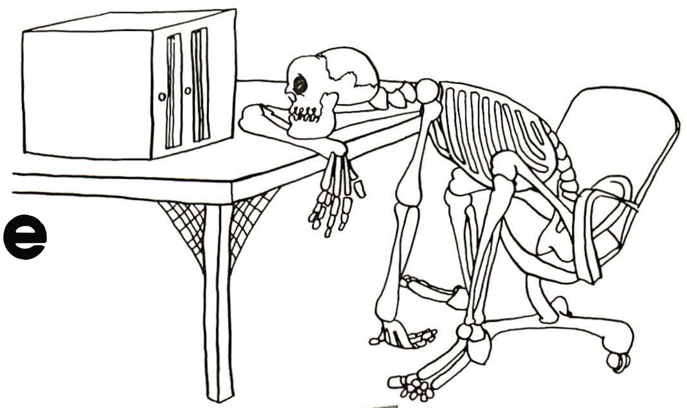
Finally, there are Heath's own service and parts distribution facilities. Service is available in many cities at Heathkit stores, and parts are shipped from the factory within 24 hours of a telephone call, if a credit-card number is provided.

Parts are not expensive, by the way. The most expensive is the print head itself, which costs $133. The next dearest (excluding the power transformer) are the paper-drive motor and F8 microprocessor, priced at $15.95 and $14.90, respectively. Considering that a service contract for a commercial printer can cost in excess of $50 per month and that a service call to replace an ailing circuit board has been known to cost over $125, the H-14 should, indeed, be very economical to operate, even in the unlikely event that a part should fail.

The H-14 does not quite satisfy my criteria for the All-American line printer, but it is certainly an excellent buy and, more important, a tough competitor for the title.■

Is BASIC too SLOW?

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Zork, The Great Underground Empire

Bob Liddil, POB 66, Peterborough NH 03458

Deep within the inky underground
Lurk things only half whispered of
And twisty hidden passages
Which hide both treasure and death.
But who can deny the challenge
Offered to he who would trespass here,
For would not the lure of gold and glory
Be worth more to a man than breath?

From Song of Zork *by*
Freerover the Bard

Adventure has evolved many times during its short history. From Crowther's and Wood's creation to the genius of Scott Adams to the wild antics of Greg Hassett, the journey has been exciting and entertaining for the fans of inventive computer puzzles. No single advance in the science of Adventure has been as bold and exciting as the introduction of Personal Software Inc's *Zork, The Great Underground Empire.*

The first thing that everyone will look for when *Zork* boots up is the blinking cursor, and the "I AM..." and "YOU SEE..." format that Scott Adams has popularized in his nine Adventures. That is not the case here. The screen layout is arranged in such a way as to move the WHERE prompt (which gives your current location in the game) down to the bottom of the screen. I found this most useful after reading ten or twelve lines of detailed area description. Additionally, the number of turns elapsed, the number of points accumulated, and the location form an information display on the bottom line of the screen. Other game information scrolls upward as the game progresses, giving a very professional screen layout for the game.

At a Glance

Name
Zork, The Great Underground Empire

Type
Adventure game

Manufacturer
Personal Software Inc
1330 Bordeaux Dr
Sunnyvale CA 94086
(408) 745-7841

Price
$39.95

Format
5-inch floppy disk

Language
Z80 machine code

Computer
Radio Shack TRS-80 Model I with 32 K bytes of memory and one disk drive

Documentation
Printed instructions included

Audience
Anyone interested in Adventure or fantasy gaming

Backup Capability
None apparent

If you happen not to have an unlimited amount of time to spend with your computer, *Zork* has a SAVE command that allows you to save your position in the game onto a blank, initialized floppy disk. While some cowards use it to retain their hard-earned position in the game before making some dangerous move, the true purpose of this command is to let you follow the game through to its ultimate end (which may take weeks), or as protection against losing your position due to, say, a brief power failure.

Zork comes on a write-protected single-density 5-inch disk with what appears to be its own operating system doing the booting and initialization. The disk defied examination by the most sophisticated methods available to me. I hope that Personal Software (which distributes *Zork*) will be able to foil the software pirates and traders for a while. The disk seems to be absolutely uncopyable.

Loading and preparing for play is simple enough. Merely insert the *Zork* disk into drive 0 and press the reset button of your computer. When the program is up and running, a pleasant block cursor greets you. You are now ready to play *Zork*.

Zork requires a 32 K-byte disk system (in this case, a Radio Shack TRS-80 Model I with 32 K bytes of memory and one disk drive) due to the eloquence of the descriptions and the large number of locations that are stored on the disk to be recalled at the appropriate times during the game. The advance copy I used had no instructions, so, in the beginning, I played a fairly straight game of Adventure.

I was eager to test *Zork*'s biggest selling point, intelligent input (ie: its ability to accept free-form instructions). I typed "OPEN THE BAG AND GET THE LUNCH," in reference to a brown paper sack inside the house. The computer complied. There was water and food, so I typed "EAT THE LUNCH AND DRINK THE WATER," to which the computer responded with gratitude for satisfying its hunger and thirst.

I was hooked.

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Exploring *Zork*

This Adventure begins in a beautiful forest near a large white house that is boarded up in an obvious attempt to keep explorers out. I managed to get into the house through the front once, but I was plunged into darkness and eaten by a monster called a *grue*. The game gave me the option of reincarnating myself, which I did (at a cost to myself of 10 points). I was revived in a forest.

Beyond the forest is a deep and beautiful canyon through which the River Frigid flows. This was the first time I had ever been at the end of the rainbow. No, I didn't see a pot of gold, but just because I didn't see it doesn't mean it wasn't there.

In these three locations (ie: house, forest, canyon), the descriptions were lavish, sparing no words in their bestowal of clues and information to the player. An ordinary jeweled treasure, in the form of a bird's egg, more than once sent me scurrying to the dictionary in search of the meanings of some of the words used to describe it.

There are many tools available to the explorer. I was able to obtain a lantern (light wards off grues), a length of rope, a nasty-looking knife, an elvish sword (which glows for reasons of its own), a refillable water bottle, a lunch, and garlic (which presumably repels Were-beings or Vampires, though I encountered none). Armed with these things, I entered the Underground Empire in search of gold and glory.

There was this pugnacious troll who popped up in the middle of a room description early in the game. Here, I got a chance to test the combat capabilities of the game. I typed "ATTACK TROLL", to which the computer supplied a supplemental *<with hands>*. Look out! Remembering that the program accepts more complex input, and, having survived the first combat turn, I typed "ATTACK TROLL WITH SWORD." This gave more satisfactory results: the troll expired, his body obligingly turning to black smoke in the interest of litter-free dungeon delving.

A thief came along shortly thereafter and challenged my right to exist in *Zork*. I typed "THROW KNIFE". He caught it in his sack and dispatched me to the netherworld, all in one swift motion. I could still hear him laughing as I lay ruefully reincarnated on the forest floor. I was ten points lighter and my possessions were scattered to the four winds. Sadder but wiser, I reentered the lower levels after 20 minutes of rounding up those items that were absolutely needed.

More cautious now, I explored the passages and tunnels of *Zork* (level 1). There are no unwarranted locations here—unless you can count the presence of a dam with color-coded control buttons in a maintenance room. Gleefully, I began pushing buttons, something I should know better than to do, as a veteran of the *Death Dreadnought* and *Strange Odyssey* Adventures. When the water level began rising, I was not concerned. Then I drowned.

The program was really getting testy with me by now. Grudgingly I was reincarnated by the Patron Deity who guards the souls of all Adventurers. Empty-handed once more, I resumed my journey. I retraced my steps to the Loud Room, where whatever you say is echoed. Then, after 768 turns and an afternoon of unparalleled enjoyment, my luck ran out. I became Grue Munchies, part of the balanced diet of silly dungeon players allotted to those carnivorous native dark dwellers of *Zork*.

On other occasions, I have been expelled from *Zork* on multiple charges of being a reckless Adventurer. Nonetheless, armed with the dubious rank of Amateur Explorer and my knowledge of the highest levels, I am looking forward to the time when I will plunge once more into the troll-, thief-, and grue-laden depths of the Underground Empire.

Zork, as peer to the Microsoft *Adventure* and heir apparent to the throngs of Adventure cultists who wait breathlessly for each new offering, is equal to the awesome task it has been given. That the program is entertaining, eloquent, witty, and precisely written is almost beside the point. Unlike the kingdoms of the Adventures for machines with 16 K bytes of memory and far from the classic counter-earthiness of the Colossal Cave in the original *Adventure*, *Zork* can be felt and touched— *experienced*, if you will—through the care and attention to detail the authors have rendered.

I've been to *Zork* today. Tomorrow, I will take a friend. Together we will unwrap the cloaks of mystery surrounding this most excellent and memorable work of computerized fiction. And when we have extracted from this land every drop of adventuring that can be obtained, we will likely not be kept waiting. A sequel is nearing completion, even as this is being written.

Somebody, please, let me know when it's done. ■

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Energy-Saving Cost/Benefit Analysis

Richard Hetherington
637 Pendleton Ave, Apt D
Chicopee MA 01020

The recent skyrocketing cost of energy makes us think of ways of conserving heat and saving money, whether by increased home insulation, using storm windows, lowering the thermostat, or any number of other methods. Cost versus benefit is always debated. How many times have you asked yourself: will the cost of adding 6 inches of insulation to the attic far outweigh the benefits?

In order to answer the cost/benefit question relating to home insulation, the mechanism of heat travel must be understood. I will briefly review the concepts of heat transfer, what influences it, and show how to use a BASIC program to make the cost/benefit decision.

Heat Transfer

Heat can travel between locations by any of three mechanisms: conduction, convection, or radiation.

Conduction is the flow of heat by molecular vibration and is usually associated with transfer through solids. For example, when a spoon is placed in a cup of hot coffee, the spoon gets hot by conduction of heat from the liquid.

Convection is the transport of heat through a fluid transporting medium by fluid movement caused by differences in density due to different temperatures, as when air picks up heat from a radiator in the home and distributes it throughout a room.

Radiation transports heat through electromagnetic energy, which is absorbed and converted to heat energy by a solid material. For instance, if you stand close to a blazing fireplace the radiant heat can become unbearable.

Heat can be lost from your home by all three mechanisms, but in most cases, the loss by conduction is most significant and is our main consideration.

The flow of heat from one place to another by steady-state conduction can be expressed by:

$$Q = T \times A / R$$

where:
Q = heat flow in BTU (British thermal units)/hour
T = temperature difference in °F (degrees Fahrenheit)
A = area of heat flow in square feet
R = resistance to heat flow in hour-square-feet-°F/BTU

The resistance to heat flow is related to the thickness of the material through which the heat is flowing, and the thermal conductivity (shown in table 1) of the material. For flat surfaces, it is found by:

$$R = L/K$$

where:
L = thickness of material in inches
K = thermal conductivity of the material in BTU-inches/hour-square-feet-°F

If the heat is traveling through more than one material then R is expressed as:

$$R = L_1/K_1 + L_2/K_2 + L_3/K_3 + \ldots$$

where:
$L_1, L_2, L_3\ldots$ = the thickness of each material through which the heat flows
$K_1, K_2, K_3\ldots$ = the thermal conductivity of each material

The R value can be calculated for any number of materials sandwiched together as long as the thickness and thermal conductivity of each material is known.

Looking at the formulas, you can see that the flow of heat depends on the temperature difference, the area it flows over, and the thickness and thermal conductivity of the material it flows through. Using these three formulas, you can readily calculate heat loss by conduction through flat surfaces.

Once the rate of heat loss is known, its cost can be calculated. Table 2 lists common fuels, the heating value of the fuel, and approximate cost of that fuel. The cost of the fuels will vary significantly depending on your location and the quantity purchased. For maximum accuracy, modify the fuel costs in table 2 to match the particulars of where you live.

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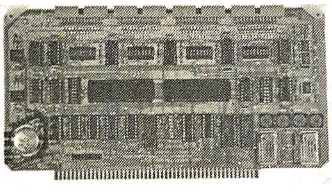
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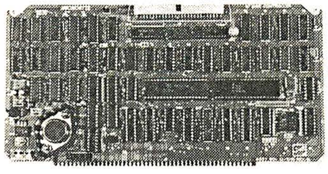
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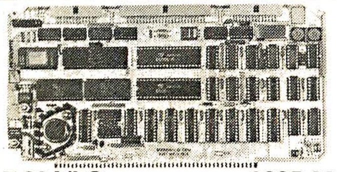
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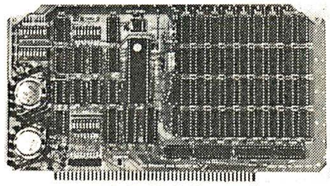
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sawdust	0.41
styrofoam	0.31
water	4.30
window glass	5.00
white pine	1.04
wood shingles	1.15

Table 1: *Thermal conductivity (K) of common materials used in construction and insulation. Note that the K for air is relatively constant for ¼-inch to 4-inch thicknesses. When entering these values into the BASIC program shown in listing 1, use the indicated figures for air (1.0 or 1.2) regardless of the thickness of the air layer. (Data is from various sources researched by the author.)*

Fuel	Heating Value (*H*)	Cost (*Z*)
L P gas	21,000 BTU/lb	$0.245/lb
hardwood	21,000,000 BTU/cord	$100.00/cord
electricity	3413 BTU/kW hr	$0.055/kW hr
anthracite coal	12,700 BTU/lb	$0.04745/lb
natural gas	1050 BTU/cu ft	$0.004845/cu ft
#2 fuel oil	138,700 BTU/gal	$0.93/gal
kerosene	135,500 BTU/gal	$0.97/gal

Table 2: *The heating value in BTUs (British thermal units) and cost of various fuels commonly used for home heating. The indicated costs are local spot prices in western Massachusetts during the winter of 1979-80 and will vary significantly in different areas. For the greatest accuracy when using the BASIC program shown in listing 1, make sure the fuel costs are accurate for your area. (Data is from various sources researched by the author.)*

The cost of heat lost is calculated by:

$$C = Z \times Q/H$$

where:
C = cost of heat lost in dollars/hour
Z = fuel cost in dollars/unit
H = heating value of fuel in BTU/unit
Q = heat flow in BTU/hour

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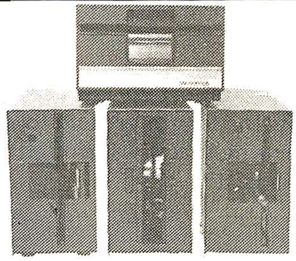
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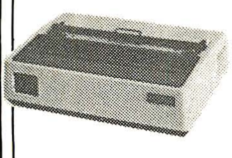


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Listing 1: *A BASIC program for cost/benefit analysis of energy-saving expenditures. Line 250 adds a constant factor to the resistance to heat flow (R) that takes into account external-surface air-film resistance. This program is written in Processor Technology Extended Cassette BASIC and can easily be modified for other BASIC systems.*

```
 10 REM--SAVE MONEY BY INSULATING
 20 REM--WRITTEN BY RICHARD E. HETHERINGTON
 30 REM--MARCH 1980
 40 FOR J=1 TO 2
 50   PRINT "FOR CASE #";J
 60   INPUT "AREA OF HEAT FLOW (SQ.FT.)? ",A
 70   INPUT "INDOOR TEMPERATURE (DEG.F.)? ",T1
 80   INPUT "OUTDOOR  TEMPERATURE (DEG.F.)? ",T2
 90   LET T=T1-T2
100   INPUT "HEATING VALUE OF FUEL USED (BTU/UNIT)? ",H
110   INPUT "COST OF FUEL USED ($/UNIT)? ",Z
120   PRINT "NUMBER OF LAYERS OF MATERIAL"
130   INPUT "THROUGH WHICH THE HEAT FLOWS? ",N
140   FOR I=1 TO N
150     PRINT
160     PRINT "FOR LAYER ";I
170     INPUT "THICKNESS (IN.)? ",L(I)
180     INPUT "THERMAL CONDUCTIVITY (BTU.IN./HR.SQ.FT.DEG.F.)? ",K(I)
190   NEXT I
200   LET R=0
210   FOR I=1 TO N
220     LET R(I)=L(I)/K(I)
230     LET R=R+R(I)
240   NEXT I
250   LET R=R+.5
260   LET Q(J)=T*A/R
270   LET C(J)=Z*Q(J)/H
280   PRINT
290   PRINT "HEAT LOST IS";Q(J);" BTU/HR."
300   PRINT "COST OF FUEL LOST IS";C(J);" $/HR."
310   PRINT : PRINT : PRINT
320 NEXT J
330 PRINT "HEAT SAVED CASE #2 OVER CASE #1 IS";Q(1)-Q(2);" BTU/HR."
340 PRINT "PERCENT OF HEAT SAVED IS";((Q(1)-Q(2))/Q(1))*100;" %"
350 PRINT "COST SAVINGS IS";C(1)-C(2);" $/HR."
360 PRINT "WHAT WILL BE THE COST TO YOU"
370 INPUT "TO ACHIEVE THIS SAVINGS? ",E
380 PRINT "PAYOUT PERIOD IS";E/(C(1)-C(2));" HOURS"
390 END
```

Another important consideration is the pay-out period. This is the length of time to recover any money spent on conserving energy through fuel savings. The pay-out period is:

$$P = E/(C_1 - C_2)$$

where:
P = pay-out period in hours
E = cost to achieve the savings (in dollars)
C_1 = cost of heat lost *before* (in dollars per hour)
C_2 = cost of heat lost *after* (in dollars per hour)

The pay-out period is the real indicator of whether you should spend the money. Generally, the shorter the pay-out period the better; however, under certain conditions pay-out periods as long as ten years may be acceptable. For example, it may take ten years to recover the cost of insulating the walls of your home. However, if it is a new home and you don't plan to move for a long time, then it will be worth it.

Listing 1 is a BASIC program that uses the equations to calculate the pay-out period and other information. The program is designed to compare two situations. Line 250 adds a constant factor to the resistance to heat flow (R) to take into account external-surface air-film resistance. This resistance becomes significant when considering materials with very low resistance to heat flow. The program is written in Processor Technology Extended Cassette BASIC.

One more thing: don't forget that you might be able to deduct money spent on energy conservation from your federal income tax! ■

Problem 1

You have purchased a home that doesn't have any insulation in the attic, and you want to insulate it with 6 inches of fiberglass insulation. The attic is 20 by 25 feet (ie: 500 square feet). The ceiling below the attic is constructed of ½-inch pine boards (K=1.04) and ½ inches of plaster (K=4). Average attic winter temperature is 40 °F and room temperature below the attic is 68 °F. The insulation will cost $110 for 500 square feet (K=0.25). The house is heated with natural gas (H=1050 BTU/cubic foot, Z=$0.004845 /cubic foot). You will do the work, so the only cost will be the insulation. Should you insulate the attic?

Solution

A 96% reduction in heat loss is indicated, and you will recover the money spent in 1970 hours (ie: 82 days) under the conditions given. Since this is less than one winter season, you should insulate.

Problem 2

You have a house identical to the one described in Problem 1, except there already are 6 inches of insulation in the attic. Should you add 6 more inches of insulation?

Solution

By adding the insulation, you will save 49% of the heat presently lost. However the pay-out period is 87,469 hours. This is 3645 days (ie: thirty winter seasons). Under these conditions it's advisable not to spend the money.

Problem 3

Your house is well insulated but doesn't have any storm windows. There are twelve windows in the house, each 3 by 5 feet. (The total window area is 180 square feet.) Combination windows cost $35 each and will be installed by a contractor for a total cost of $600. (The total job cost is $1020.) The average outside winter temperature is 35° F, and the inside temperature is 72°F. The house is heated with electricity (H=3413 BTU/kW-hour, Z=$0.055/kW-hour). Should the combination windows be installed?

Material the heat passes through is:

Case 1: one layer of glass (L=0.125 inches, K=5)
Case 2: two layers of glass (L=0.125 inches each, K=5)
one layer of air (L=1 inch, K=1)

Solution

There is a 66% reduction in heat lost through the windows. The cost savings is quite high at $0.135 per hour. But the installation cost is so high that the pay-out period is fairly long (about three winter seasons). The best plan would be to look for a cheaper contractor and then have the windows installed.

A Variable Type Converter for Numerical Quantities

Mike Moskowitz, 23400 E Silsby, Beachwood OH 44122

Listing 1: *A Hewlett-Packard BASIC program that converts string variables to numeric variables.*

```
10   REM MIKE MOSKOWITZ
20   REM CONVERTS STRING VARIABLES TO NUMERIC VARIABLES
30   DIM A[50],B[50],C[50],D[50],E[50],A$[50]
40   A=C=D=E=0
50   B=1
60   A$=""
70   PRINT "#";
80   INPUT A$
90   C=LEN(A$)
100   FOR D=C TO 1 STEP -1
110   IF A$[D,D]="0" THEN 220
120   IF A$[D,D]="1" THEN 240
130   IF A$[D,D]="2" THEN 260
140   IF A$[D,D]="3" THEN 280
150   IF A$[D,D]="4" THEN 300
160   IF A$[D,D]="5" THEN 320
170   IF A$[D,D]="6" THEN 340
180   IF A$[D,D]="7" THEN 360
190   IF A$[D,D]="8" THEN 380
200   IF A$[D,D]="9" THEN 400
210   GOTO 410
220   E[D]=0
230   GOTO 410
240   E[D]=1
250   GOTO 410
260   E[D]=2
270   GOTO 410
280   E[D]=3
290   GOTO 410
300   E[D]=4
310   GOTO 410
320   E[D]=5
330   GOTO 410
340   E[D]=6
350   GOTO 410
360   E[D]=7
370   GOTO 410
380   E[D]=8
390   GOTO 410
400   E[D]=9
410   A=A+E[D]*B
420   B=B*10
```

Listing 1 continued on page 272

In most versions of BASIC, there are some operations and functions which can be performed only on alphanumeric (string) variables and not on numeric variables. Likewise, there are operations which will work only on numeric variables and not on strings. For example, most BASICs will accept operations such as these:

```
10  A=LEN(A$)
20  PRINT A$(1,1)
30  LET A=B*C
40  PRINT SQR(A)
```

But these statements are illegal in BASIC:

```
10  A=LEN(A)
20  PRINT A(1,1)
30  LET A$=B$*C$
40  PRINT SQR(A$)
```

It would be convenient to have a subroutine which would convert numeric quantities stored in string variables into numeric variables, and vice versa. This would allow all numeric quantities to gain the use of both types of functions, regardless of the type of variable they were originally assigned to. This is an easy task in some of the newer, more powerful BASICs which allow access and manipulation of ASCII representations. Most BASIC systems, however, do not have this capability.

Listing 1 converts numbers from strings to numeric variables. This subroutine is invaluable when some number which must be operated on arithmetically is embedded in an input string. Listing 2 converts numbers from numeric variables into string variables. It allows numeric quantities to receive the use of operations such as substring selection, A$(X,Y), and the LEN function. These subroutines may be improved by modifying them to accommodate decimal points or scientific notation. These programs were written in BASIC on a Hewlett-Packard 2000E computer, and may need slight modifications, but will run on many microcomputer BASICs. ■

Listing 1 continued:

```
430  NEXT D
440  PRINT A
450  PRINT
460  GOTO 30
470  END
```

Listing 2: *A program that converts numeric variables to string variables.*

```
10   REM MIKE MOSKOWITZ
20   REM CONVERTS NUMERIC VARIABLES TO STRING VARIABLES.
30   DIM A[50],B[50],C[50],D[50],X[50],A$[50]
40   A=B=C=D=X=0
50   A$=""
60   PRINT "#";
70   INPUT A
80   B=B+1
100   IF INT(A/10↑B)=0 THEN 120
110   GOTO 80
120   FOR X=1 TO B
130   D[X]=((A-INT(A/10↑X)*10↑X)-(A-INT(A/10↑(X-1))*10↑(X-1)))/10↑(X-1)
140   NEXT X
150   C=1
160   FOR X=B TO 1 STEP -1
170   IF D[X]=0 THEN 270
180   IF D[X]=1 THEN 290
190   IF D[X]=2 THEN 310
200   IF D[X]=3 THEN 330
210   IF D[X]=4 THEN 350
220   IF D[X]=5 THEN 370
230   IF D[X]=6 THEN 390
240   IF D[X]=7 THEN 410
250   IF D[X]=8 THEN 430
260   IF D[X]=9 THEN 450
270   A$[C,C]="0"
280   GOTO 460
290   A$[C,C]="1"
300   GOTO 460
310   A$[C,C]="2"
320   GOTO 460
330   A$[C,C]="3"
340   GOTO 460
350   A$[C,C]="4"
360   GOTO 460
370   A$[C,C]="5"
380   GOTO 460
390   A$[C,C]="6"
400   GOTO 460
410   A$[C,C]="7"
420   GOTO 460
430   A$[C,C]="8"
440   GOTO 460
450   A$[C,C]="9"
460   C=C+1
470   NEXT X
480   PRINT A$
490   PRINT
500   GOTO 10
510   END
```

Microcomputers in the Chemistry Laboratory

Robert P DeSieno, Director, Computer Services Center,
Davidson College, Davidson NC 28036

Editor's Note: *Since writing this article, Mr DeSieno has moved from Westminster College, New Wilmington, Pennsylvania, to his present post at Davidson College.*

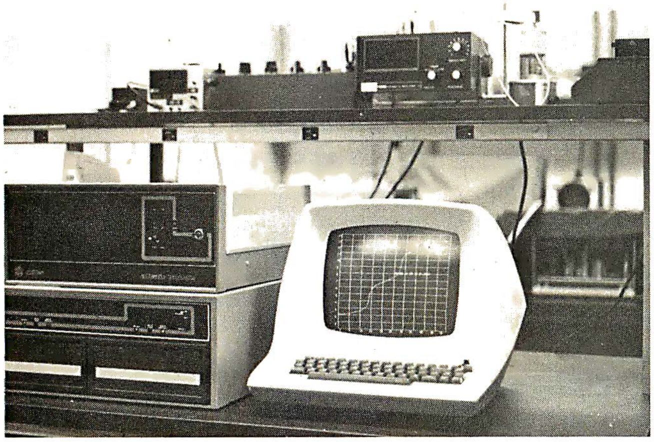


Photo 1: *An Altair 8800b microcomputer, floppy-disk drive, and Lear-Siegler ADM 3A terminal interfaced to a pH meter.*

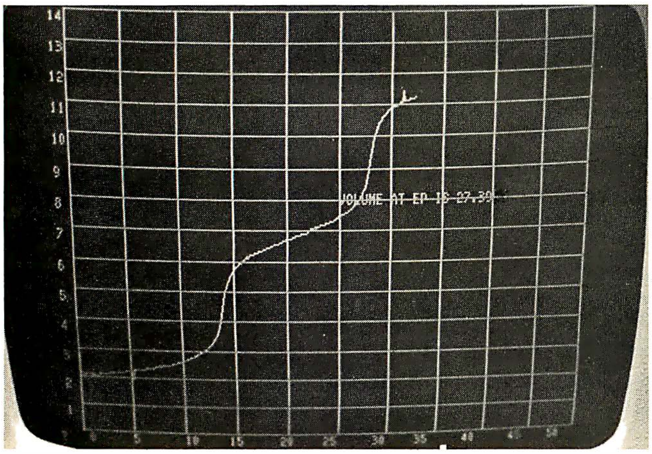


Photo 2: *The graphics display presented by an RG-512 Retrographics card in the Lear-Siegler terminal. The Y axis is calibrated in units of pH, the X axis in milliliters of titrant. The plot is a titration curve for the reaction between sodium hydroxide and phosphoric acid.*

The advances in microcircuitry, the production of solid-state components, and the development of microcomputers provide small chemistry departments with inexpensive resources for interfacing computers and laboratory instruments (see references 1 and 2). Marketed by a cottage industry that serves hobbyists, microcomputers and their peripheral devices offer faculty and students modern means to gather data, process information, and enrich their understanding of chemistry.

Equipment and Hardware

In the last three years, faculty and students in the Chemistry Department of Westminster College built from kits an Altair 8800b microcomputer, a Lear-Siegler ADM 3A terminal, 48 K bytes of dynamic memory, two serial ports, and four parallel ports. In addition, the department bought a graphics module (Digital Engineering RG-512 Retrographics card) for the Lear-Siegler terminal and a MITS 3200 disk drive. We assembled these components into a system (see figure 1 and photo 1) that samples the output of gas chromatographs, spectrophotometers, or pH meters, stores data on disks, calculates results, and displays information on a video terminal and a printer.

To change analog signals into digital information for the computer, we use a digital-panel meter (Analog Devices AD2010 DPM) that converts signals in the range ±199.9 mV into 3½ binary coded decimal (BCD) numbers and displays the data transferred to the computer. We program a Motorola PC6820 Peripheral Interface Adapter (PIA) to handle two status bits and thirteen parallel-data bits transferred between the computer and the DPM. The DPM delivers data at controlled rates up to a maximum of 24 readings per second, a pace sufficiently rapid for many instrumental measurements of chemical behavior.

Laboratory Activity

To introduce techniques of interfacing, we guide upper-level students for four weeks while they use a microcomputer to study the rate of reaction between ferric and iodide ions and determine titration curves for reactions between acids and bases.

Students use an ultraviolet-visible spectrophotometer (Bausch & Lomb Spectronic 20) set at a wavelength of 425 nm (nanometers) to observe the increasing absorbance of light in a solution of ferric and iodide ions. Triiodide ions, a product of the reaction in solution, cause the growth of absorbance and the changing absorbance signal in the spectrophotometer reflects the rate of

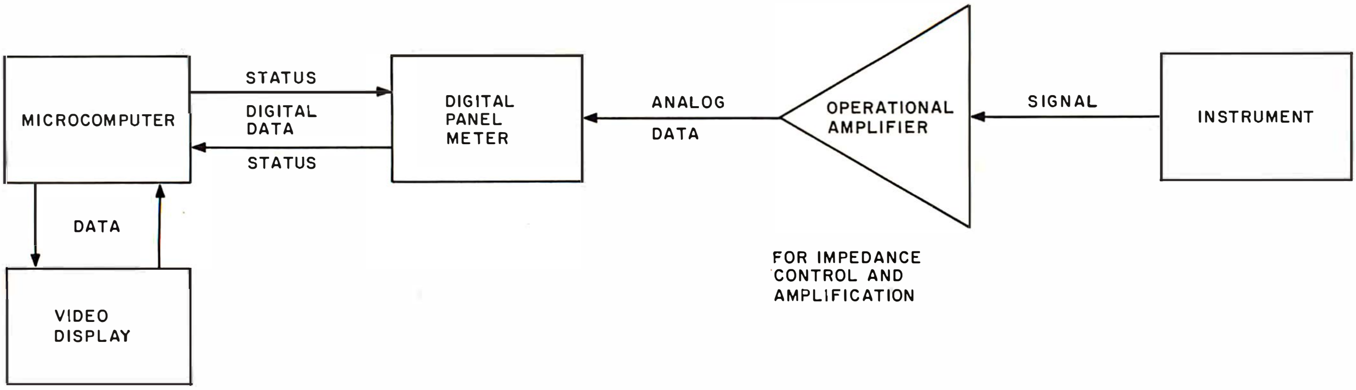


Figure 1: *Block diagram for interfacing a laboratory instrument and a microcomputer.*

this reaction. The absorbance signal is captured at the amplifier of the spectrophotometer and delivered through the DPM to a parallel port of the computer. To transfer data to the processor and calculate rate constants, exponents of terms, and energy of activation from their rate studies, students program the microcomputer in Extended Disk BASIC.

To trace the behavior of acid-base titrations, students use a combination glass and reference electrode to measure changing concentrations of protons in solution and deliver changing potential differences between these electrodes to a pH meter. A syringe driven by a pump delivers the base at a fixed rate into the acid to be titrated. A clock controlled by software coordinates the rate of travel for a vector across the video screen with the rate of delivery of base. The clock and the pH meter (by way of the DPM and a port) provide pairs of data needed to use the graphics terminal as an x,y plotter (see photo 2).

Educational Approach

These projects embody chemistry that our students have studied earlier in laboratories of lower-level courses. This earlier experience lends confidence to students and helps them concentrate more effectively on the details of interfacing. Students compare results from observations made with the aid of interfacing to results they obtained from earlier studies and to information reported in the literature. Such comparisons impress upon them the value of checking conclusions on the way to scientific understanding.

Students learn quickly that interfacing a microcomputer to a laboratory instrument requires comprehensive understanding of the work they will do. To attain their goals, they must:

- become familiar with the theory of the measurements they will make in order to write and test software that instructs the computer to calculate results and establish a format for reporting information
- connect the computer with the aid of appropriate hardware to the instrument
- use and test software that will control the transfer of information between the computer and the instrument (handshaking)
- prepare and standardize solutions required for the project

To help students develop the skills they will need, we assign exercises that familiarize them with our microcomputer, an instrument, and the details of interfacing these devices. We divide students into two groups: those who have programmed and those who have not.

Students who have programmed refresh their skills by programming with Extended Disk BASIC to calculate physical properties and chemical behavior of gases, liquids, solids, and solutions. We assign tutorials in computer-aided instruction to students who have had no programming experience and work closely with these students until they grasp the fundamental qualities of programming and can also use the computer to solve

dBASE™ II vs. the Bilge Pumps.

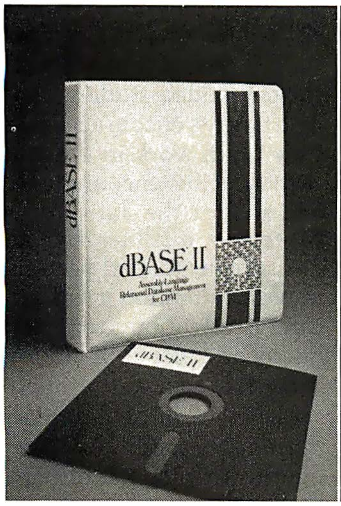
by Hal Pawluk

We all know that bilge pumps suck.

And by now, we've found out—the hard way—that a lot of software seems to work the same way.

So I got pretty excited when I ran across **dBASE II**, an assembly-language relational Database Management System for CP/M. It works! And even a rank beginner like myself got it up and running the first time I sat down with it.

If you're looking for software to deal with your data, too, here are some tips that will help:





Tip #1: Database Management vs. File Handling:

Any list or collection of data is, loosely, a data base, but most of those "data base management" articles in the buzzbooks are really about file handling programs for specific applications. A real Database Management System gives you data and program independence (no reprogramming when data changes), eliminates data duplication and makes it easy to turn data into information.

Tip #2: Assembly Language vs. BASIC:

This one's easy: if you're setting up a DBMS, you're going to be doing a lot of sorting, and Basic sorts are s-l-o-w. Run a benchmark on a Basic system like S*-IV against a relational DBMS like **dBASE II** and you'll see what I mean. (But watch it: I've also seen one extremely slow assembly-language file management system.)

Tip #3: Relational vs. Hierarchal & Network DBMS.

CODASYL-like hierarchal and network systems, around since the 1960's, are being phased out on the big machines so why get stuck with an old-fashioned system for your micro? A relational DBMS like **dBASE II** eliminates the predefined sets, pointers and complex data structures of a CODASYL-type DBMS. And you don't need to be a programmer to use it.

dBASE II vs. everything else.

dBASE II really impressed me.

Written in assembly language (with no need for a host language), it handles up to 65,000 records (up to 32 fields and 1000 bytes each), stores numeric data as packed strings so there are no round-off errors, has a super-fast multiple-key sort, and supports ISAM based on B* trees.

You can use it interactively with English-like commands (DISPLAY 10 PRODUCTS), or program it (so when you've set up the formats, your secretary can do the work). Its report generator and user-definable full screen operations mean that you can even use your existing forms.

And if all this makes your mouth water, but you've already got all your data on a disk, that's okay: **dBASE II** reads your ASCII files and adds the data to its own database.

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problems in chemistry. Eight to ten hours of programming on an interactive terminal, guidance from a teacher, and help from other students give all students the ability and confidence to use the computer for elementary interfacing operations.

To help students understand how information is transferred between the computer and an instrument, a process called input/output or I/O, we provide hard and disk copies of routines that manage I/O. Students study these routines and explore the relationships between hardware and the software that executes I/O. The students then embed their software for calculating results within these routines and synthesize a program that controls transfer of information among instrument, computer, and disk files, as well as presents results at the video terminal.

When students have completed these tasks, we provide sample data retrieved from disk files so they can simulate their experiments and test and correct their programs. Assured of hardware and software that work, students complete their lab work by selecting substances and concentrations that will provide a range of data commensurate with the most reliable operation of the instrument and the computer. To enhance their understanding of interfacing, students write a comprehensive report that describes the procedures and apparatus they have used, as well as the relationships between what they measure, how they measure, and what they conclude. These reports reveal that the careful attention to detail inherent in the use of computers improves the quality of our students' laboratory work.

Conclusions

We have just begun to teach interfacing of computers in the laboratory. Yet, we believe that such teaching is valuable and conclude:

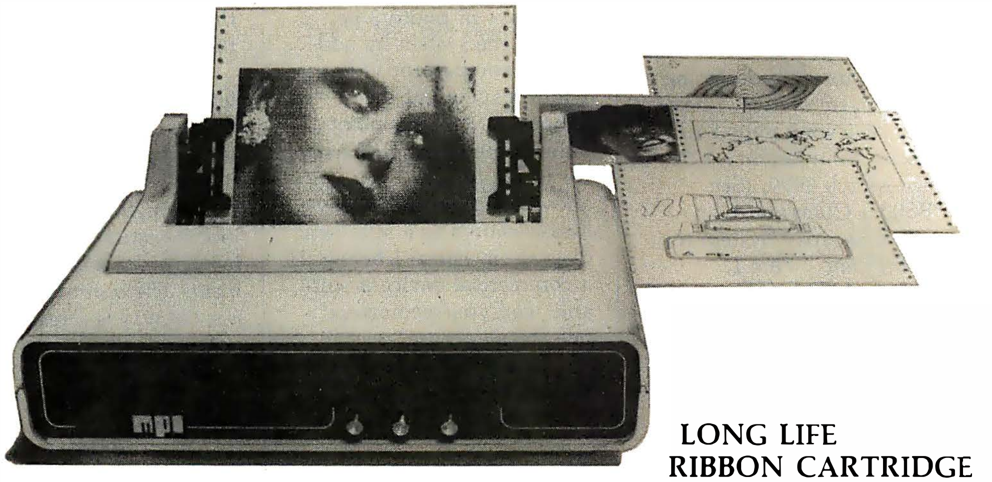
- Many students who have not used computers fear them and the specific action required to use them successfully.
- Once they use microcomputers to solve traditional problems in chemistry, students develop confidence and approach interfacing with enthusiasm.
- Because students can write software to analyze data only if they possess understanding and expectations of their intended studies, interfacing microcomputers with instruments encourages them to study their project before they begin work in the laboratory.
- Interfacing encourages students to gather more data and analyze the statistical reliability of their information. Moreover, qualities such as signal-to-noise ratio, rates of measurement, and detection limits, frequently given minimal attention in traditional laboratory work, receive careful attention from students when they interface a microcomputer to a laboratory instrument.
- By interfacing the microcomputer with instruments, students learn the differences between analog and digital information and how to report precision and significant figures with the aid of hardware and software.
- Writing software compels students to select a format for information they will report. Thus, experiments that use interfacing encourage students to consider their reader as they use the computer to prepare charts, tables, or outlined presentations of their data and conclusions.
- Interfacing encourages students to blend the systematic use of a computer with their experimental work. Thus, students use, to their benefit, flowcharts to select and guide laboratory activity, or design software for their projects.
- Interfacing of computers encourages a sense of community among students in the laboratory. We urge them to solve their experimental and software problems independently and this produces a variety of solutions for gathering and interpreting data with the aid of the computer. Students enjoy comparing solutions and merging ideas that improve on the techniques they have used.

Our students have emerged from these projects with more confidence in their ability to solve problems. From interfacing, our faculty has gained a more comprehensive basis for discussing the design of laboratory projects and the significance of results that students report. Interfacing microcomputers in the laboratory has guided our students to more detailed awareness of cause and effect. We are designing other interfacing projects that will extend similar educational benefits to students in other laboratories of this department. ■

References

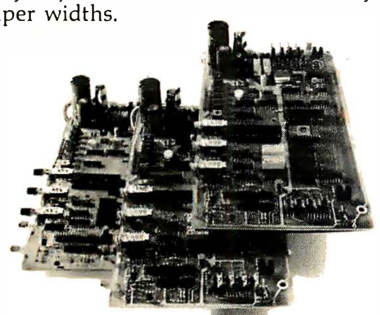
1. *Scientific American*, 237 (3), September 1977; *The Physics Teacher*, 16 (10), October 1978.
2. Gerhold, et al, "Bits, Bytes, Boards, Buses, and Beyond," *J. Chem. Ed.*, 56 (3), 701 1979.
3. Fudge, A J and Sykes, K W, *Journal of the Chemical Society*, 119, January-March 1952.
4. Hershey, A V and Bray, W C, *Journal of the American Chemical Society*, 58, 1760, 1936.

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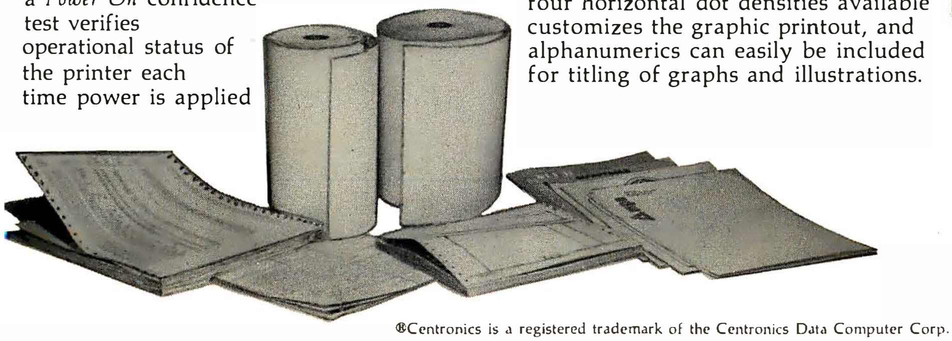
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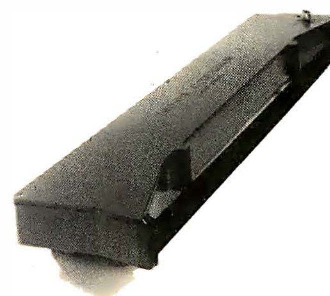
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Conducted by Steve Ciarcia

Sensing Alarms

Dear Steve,

I am currently designing a home-alarm system. I have been reviewing your BYTE articles from January 1979 thru March 1979. (See "Build a Computer-Controlled Security System for Your Home," Part 1, January 1979 BYTE, page 56; Part 2, February 1979 BYTE, page 162; Part 3, March 1979 BYTE, page 150.) I am hoping that you can clear up a couple of questions I have about your articles.

For a little background, my computer system is based on a Z80 microprocessor, rather than the 8085. I will be using sensors which you described in your article, and that is where my questions arise.

To begin with, I refer to photo 3 (January 1979 BYTE, page 68) and figure 1 (March 1979 BYTE, page 151). Is the LM3911 integrated circuit equivalent to the sensor in photo 3? Can the sensor in photo 3 be used in the system by adding the comparator in figure 1, but leaving out the temperature trigger-point potentiometer, since the sensor in photo 3 will trip above a certain point? My idea is shown as a schematic diagram in figure 1 below. If a commercial device is suitable, can you recommend one for me to use?

Thank you for your time.

Brian P Mulhearn

The sensor shown in January's photo 3 is simply a temperature sensitive switch (shown here as figure 2). It operates like any push-button switch. It is either open or closed. When the temperature is below 135° F it will be open, and above that temperature it will be closed. The circuit in figure 2 is a way to test these devices. It consists of an LED (light-emitting diode) and a 6 V battery. Just dip the sensor in hot water and the LED should light.

The LM3911 is a linear integrated circuit and not a mechanical switch. It uses the difference in emitter-base voltage of transistors (operating at different current densities) as the basic temperature sensitive element. The output voltage of the LM3911 is directly proportional to temperature in degrees Kelvin (10 mV/°K). External resistors can scale this to any desired value through an op amp. Internally, the LM3911 appears as in figure 3. The device itself is the temperature sensor. To measure the temperature of a water pipe, the LM3911 would have to be placed against the pipe. To make it operate like the mechanical sensor, a comparator is added which trig-

Figure 1

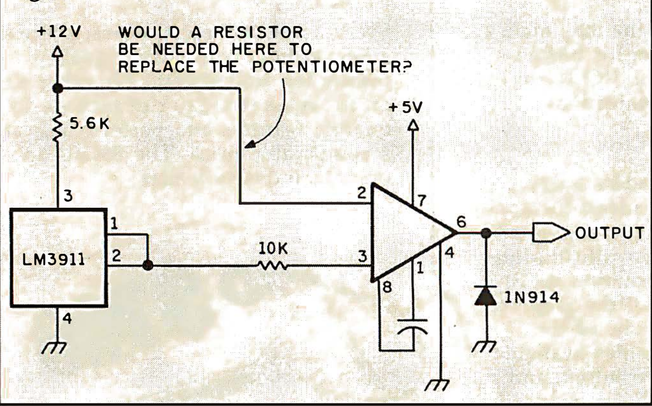


Figure 2

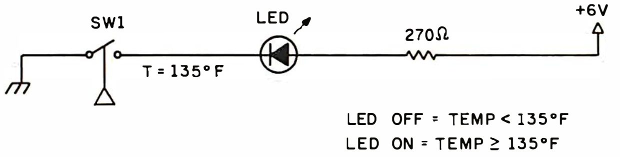


Figure 3

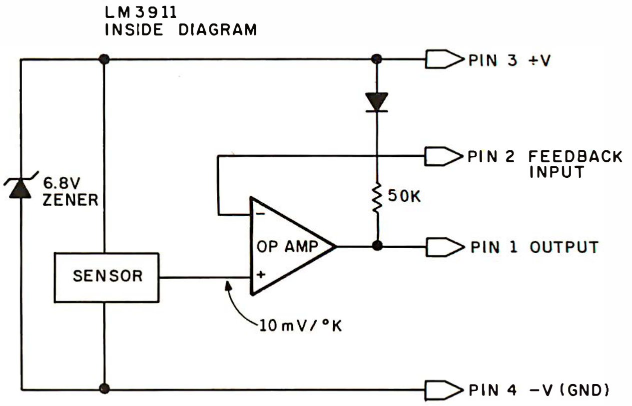


Figure 4

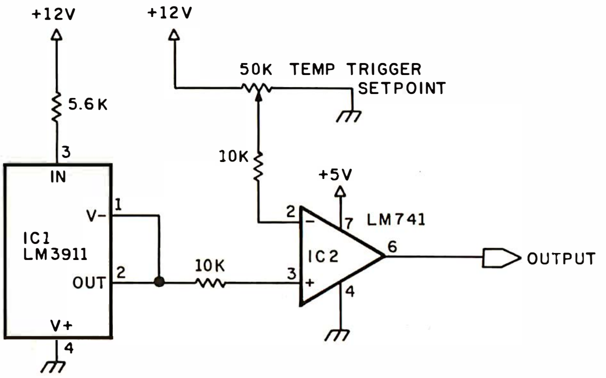
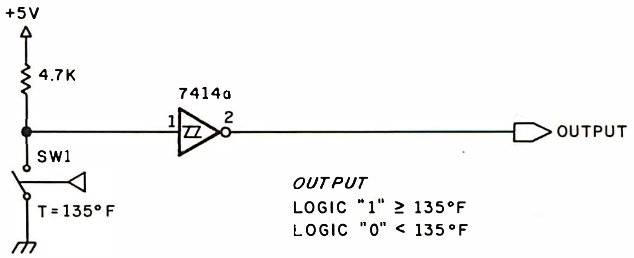


Figure 5



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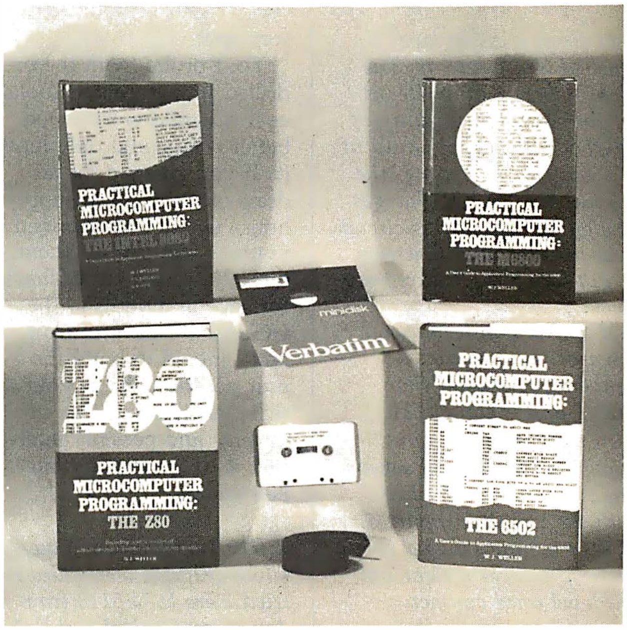
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gers when a preset level is reached (see figure 4). The 50 k-ohm potentiometer is set for some temperature of interest. When the output of IC1 exceeds the setting, the output state of IC2 changes. The advantage of this circuit over the mechanical sensor is that any temperature may be set.

It appears that you want a sensor that signifies a temperature greater than 135° F and is compatible with the computer input. Using the mechanical sensor, this can be accomplished with the circuit in figure 5. A 7414 Schmitt-trigger inverter produces a clear output level once contact bounce has ceased. If you prefer, CMOS (complementary metal-oxide semiconductor) devices can be used instead to reduce power requirements.... **Steve**

Probing for Probes

Dear Steve,

This is a nontechnical request, but I sure hope you can help me.

I have been trying for two months to locate an outlet for the type of probes shown in photo 5 of your article "Mind Over Matter: Add Biofeedback to Your Computer," (June 1979 BYTE, page 56). After a letter, three Telex messages, and three telephone calls to American Optical (both east coast and west coast), I finally received a reply from Cambridge Instruments, formerly American Optical, Medical Division, saying, "We don't make the probes, and we don't know anyone who does."

I wear a transcutaneous electronic nerve stimulator over a shoulder injury. The flat carbonized-rubber probes, held on with separate adhesive, sometimes lift free of skin contact when I am active. The normal 40 V 23 μs pulse (loaded voltage) goes up to about 400 V open line voltage. When it again contacts the skin, it arcs and makes a sore spot.

Your probe, with the predrilled sponge center, looks as if it would work much better—if I could only locate it. If you give me the address of the medical supply house where you obtained yours, I will contact them directly. I used biofeedback for several months at the UCLA Pain Control Unit, and I intend to build the unit you describe in your article, using a scope as an output, and possibly interface it to a computer later.

Bob Vinson

The two kinds of silver/silver-chloride electrodes I tried were P/N 5113 from American Optical and P/N 14245B from Hewlett-Packard. The probes themselves were nothing more than fancy clips at the end of 3 feet of shielded cable. When using three probes as shown in the article, the three shields are connected together and attached to the guard input of the isolation amplifier.

I hope this information helps.... **Steve**

Remote Data Entry

Dear Steve,

I have been trying to find a way of interfacing inexpensive terminals (calculator-pad type) to the TRS-80. I have also been trying to locate a method for doing this with as many as thirty-two terminals. The system would be used as a feedback device for working with small to classroom-size groups. Can you give me any leads to manufacturers of hardware, designers of such systems, and persons who have expertise in such matters?

Brother Eugene Meyerpeter, SM

In the September 1980 BYTE, my "Circuit Cellar" article was entitled "Build a Low-Cost, Remote Data-Entry Terminal" (see page 26). And it is exactly what you need. To build this terminal, it takes essentially a calculator pad, which you make into a serial terminal using only two integrated circuits. All communication is at 1200 bps (bits per second), full duplex.

To use it in your environment, you would build thirty-two of them and attach them to the TRS-80 through a serial port (such as the Radio Shack TRS-232 board or a COMM-80). To communicate with a single student, you would need a 32-position switch to allow you to select the individual line from that student's terminal. All outputs to the remote terminals can be tied together when you want the same message sent to all units simultaneously.

I have presented the design, but I don't know anyone producing it currently. Perhaps you could find an enterprising person who would custom-build thirty-two of them for you from my schematic.... **Steve**

Voltage Fluctuations

Dear Steve,

I have a Radio Shack TRS-80 Model I. Occasionally the machine acts strangely, either by "locking-up" so that the reset button must be used to start it again, or by randomly accessing the disk. When I first got the disks, the problem with the random accesses was quite frequent. I have since purchased Radio Shack's power-line filter and it seems to have almost eliminated the problem.

I suspect that the difficulty is caused by fluctuations in the voltage in my office. I have noticed interference on the video display when running the printer and when the air-conditioning unit starts. However, neither of these seems to cause the problem, at least, not consistently.

The landlord says that the power service into the building is 600 amps. Also, certain offices having unusual power requirements have their own circuits within the building (not, however, separate service entirely). He also has some sort of transformer that he says should eliminate fluctuations caused by the air conditioners.

My questions are:

- Is the TRS-80 sensitive to power fluctuations?
- If so, how can I monitor the circuits in my office to determine whether the computer's requirements are being met?
- If the circuits aren't adequate, is there any way to shield the computer from the fluctuations?
- If power fluctuations aren't to blame, what might be?

I have no knowledge of electronics, so I would be interested in either buying or renting (or borrowing) whatever I might need to solve the problem, rather than building something.

Guerri F Stevens

Intermittent operation and bizarre behavior are by no means limited to the TRS-80. It can be a problem with any computer installed and operating under what might be termed marginal conditions. There are quite a few TRS-80s, so, if just 1% have problems, approximately 3000 people would have complaints.

The first order of business is to determine the source of the problem. Three possibilities immediately come to mind:

- *bus cabling between peripherals*
- *power fluctuations*
- *power-line transients and induced noise*

Make sure you keep the interconnecting cables between peripherals away from power lines and as short as possible. Do not leave equipment attached directly to the computer that is not powered or properly terminated. Keep the bus cabling and disk cables away from the left side of the

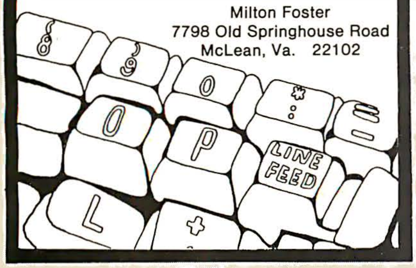
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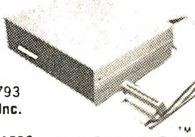
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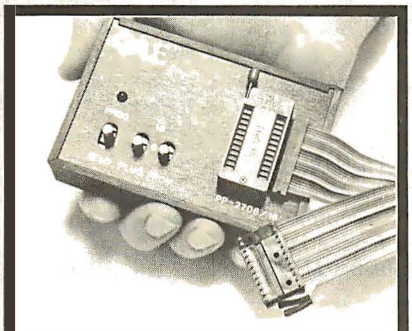


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(918) 664-2255.

video display (where it can pick up noise from the high-voltage flyback transformer).

Power fluctuations can indeed cause marginal operation. In my mind, however, there are two separate problems: fluctuations *and* transients. Fluctuations are slow (greater than 5 ms) voltage changes involving a 10 or 20% variation in line voltage. As long as the line voltage does not dip below 105 V AC, you should be all right. Have you ever noticed your room lights dim when you plug in a toaster or an air conditioner? Well, that dimming of the lights is a typical case of power-line fluctuation. A drop of only a few volts will visibly dim a lamp. Fixing this problem is easy, but it is expensive.

Transients, on the other hand, are fast (1 μs to 5 μs) changes in line voltage. Generally these are caused by the inductive kickback of motors and equipment. Usually, the more sophisticated measures employed to limit general line noise (a power-line filter) will eliminate this problem as well. If you have particularly strong narrow-band noise, then a special low-pass filter may have to be used. For example, if the reason your computer malfunctions is the 200 W radio transmitter from the business next door, then a 30 MHz filter might be required.

The fact that you have no knowledge of electronics limits the diagnostic tests that you could use to determine the problem. If you can find a nearby Radio Shack store (or, perhaps, a friendly technician) where you can obtain a VOM (volt-ohm-meter), set it on the 200 V AC range and put the probes in the wall socket next to the computer. The "safe range" is between 110 and 120 V AC. If, however, you notice the indicator taking a dive every now and then, you have a line-regulation problem. This is only a rudimentary check, because the meter has slow response. Checking for line noise and transients requires an oscilloscope (to see the fast pulses).

If you find you need better power-line regulation, you will have to resort to a constant-voltage transformer from the power company (or it may be installed privately). Two companies to contact for further information are: Sola Electric, 1717G Busse Rd, Elk Grove Village IL 60007, (312) 439-2800, and California Instruments, 5150G Convoy St, San Diego CA 92111, (714) 279-8620. Finally, if all else fails, you could encase the entire computer in copper screening and run it from a battery. See my article on "Electromagnetic Interference" in last month's BYTE. . . .**Steve**

Should I, or Should I Not?

Dear Steve,

I would like your opinion on the purchase of a computer through mail order.

Although a Radio Shack dealer is only a 5-minute walk from my house, the discounts offered by out-of-state dealers on the TRS-80 make a mail-order purchase very tempting. Can you give me your thoughts before I send a $700 check to someone sight unseen?

David Kupferman

The only sure way to tell the winners from the losers in the mail-order business is with time. No company that is crooked will be in business very long. Remember that there have been those occasions where many people were swindled in a short period of time, as happened with World Power Systems. For the most part, the good prevail.

I suggest that you review past issues of BYTE and look for advertisers who have been there for a long time and have steadily increased their product line. This will give you some indication of stability and market responsibility.

While it is always good to go to a store and see the item that you are purchasing, much can be gained from mail-order buying. In general, mail-order outlets offer discounts well below the store prices, and, when you order outside of your home state, you usually pay no sales tax; however, you often pay shipping costs.

*If you are still concerned, find someplace that takes cash-on-delivery orders and pay for your computer when it arrives on your doorstep. . . .***Steve**

Modem

Dear Steve,

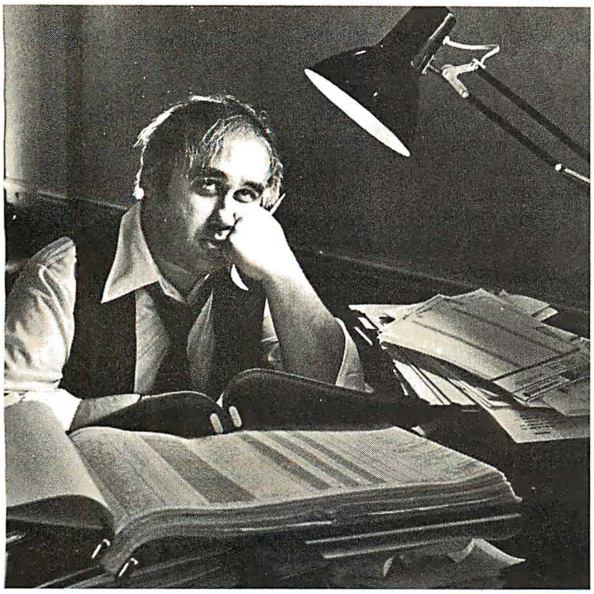
Thanks for the article on modems. (See "A Build-It-Yourself Modem for Under $50," August 1980 BYTE page 22.) It got me thinking about something.

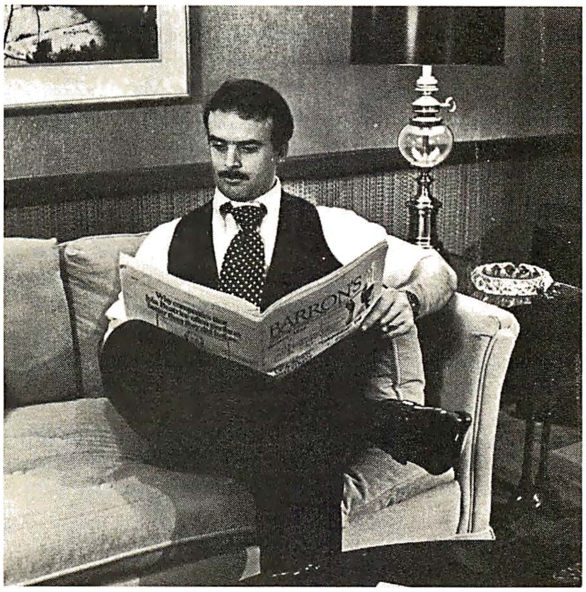
I am an ACM (Association for Computing Machinery) member at OSU (Ohio State University). I am lucky enough to be able to have an open account on computers like the DEC PDP-10, IBM 370, and PDP-11. To log onto the system, you call a telephone number, and I would like to use the modem you described to do this from my dorm room. (I have to walk about fifteen blocks to get to the computer center, and, boy, is it cold in the winter.)

How can I build a cheap keyboard/modem/television set terminal? I can wire-wrap and understand schematic diagrams. I know a bit about computers but not a lot.

Marc Taylor

At first I was going to point out that there have been numerous articles in previous issues of BYTE on the design and construction of a video terminal. There are also some kits offered for less than $200 in the advertisements at the back of every issue. At least that's what I was going to say.




BARRON'S

However, I have changed my mind in favor of practical reality.

Microcomputers and terminals configured from them are becoming cheaper all the time. It isn't quite like the 6-transistor radio or the calculator—yet. But, you may find that the cost of building a terminal is greater than what it costs to buy one. This is especially true if you purchase used equipment.

Also, the new Radio Shack Videotex combination terminal and modem for $399 is worth investigating. It sounds exactly like what you need—at a reasonable price.

*As soon as I can get a chance, I'm going to attempt to make a terminal using the Sinclair ZX80 computer. How does a $300 smart terminal sound?...***Steve**

Shedding Some Light

Dear Steve,

My name is Chris Richard, and I'm 13 years old. I am doing a science project called "Talking on a Beam of Light." I saw your article in the May 1979 BYTE (see "Communicate on a Light Beam," page 32), and I was wondering if you could tell me where I can buy some optical fibers. Could you also send me a list of reading material on optical communications; I am especially interested in getting several plans for optical transmitters and receivers.

I really enjoyed your article, and I learned a lot from it. Thank you for any help you can give me.

Chris Richard

The best sources of information on optical fibers are the manufacturers themselves. Many of them publish application notes which are usually free for the asking. Three of the largest suppliers are: Amp Inc, 449G Eisenhower Blvd, Harrisburg PA 17105; Corning Glass, Electronic Products Division, Department G, Houghton Pk A2, Corning NY 14830; and Galileo Electro Optics, Department G, Galileo Pk, Sturbridge MA 01918.

Another source of circuits comes from optoelectronics manufacturers application notes. These are companies with familiar names like Texas Instruments, General Instrument, General Electric, and Hewlett-Packard. Any good library should have an electronics manufacturers product directory. Ask the librarian if he or she has the Gold Book *or* EEM Directory.

As far as getting optical fiber materials, unless you want a few thousand feet of cable, I suggest you write for a catalog from: Edmund Scientific Company, Department G, E Gloucester Pike, Barrington NJ 08007.

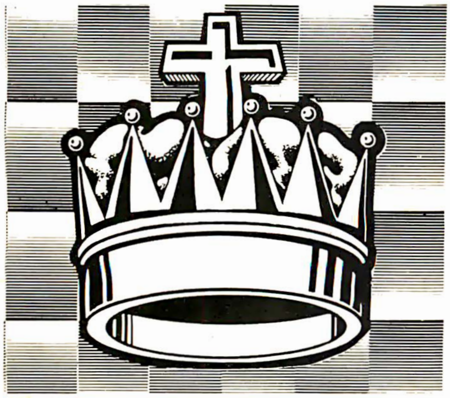
*I think you have chosen a good subject. I wish you luck. When you write to the optics companies, tell them it is for a science fair project. You may find them to be very helpful....***Steve**■

In "Ask BYTE," Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to:

Ask BYTE
c/o Steve Ciarcia
POB 582
Glastonbury CT 06033

If you are a subscriber to The Source, send your questions by electronic mail or chat with Steve (TCE317) directly. Due to the high volume of inquiries, personal replies will be given as time permits. Please enclose a self-addressed, stamped envelope, and be sure to include "Ask BYTE" in the address.

Circle 195 on inquiry card.



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SARGON II (Spracklen) The Champ of champs. "...an excellent program which will provide a true challenge for many players...Save your money and buy SARGON II..." *'80 Software Critique.* *03403, TRS-80 Level II; 03404, Apple II; 03410, OSI C1P; 03440, OSI C4P; 03401, PET; each tape $29.95. 03408, TRS-80 Level II Disk; 03409, Apple II Disk; 03414, OSI C1P Disk; 03444, OSI C4P Disk; 03484, C8P Disk; each $34.95*

BLACKJACK MASTER: A Simulator/Tutor Game (Wazaney) A serious game that performs complex simulations and evaluations of playing and betting strategies. *05303, TRS-80 Level II tape, $24.95; 05308, TRS-80 Disk Version, $29.95*

REVERSAL (Spracklen) Winner of the software division of the *First International Man-Machine OTHELLO™ Tournament*, this version of the 200-year-old game Reversi, features 27 levels of play and high-resolution color graphics. *07004, APPLE II tape, $29.95; 07009, APPLE II Disk, $34.95*

APPLESOFT UTILITY PROGRAMS (Gilder) Increase your BASIC programming speed and flexibility. Contains 9 useful subroutines: 1. REM Writer 2. PRINT Writer 3. POKE Writer 4. Hexadecimal/Decimal Converter 5. Line Counter 6. Renumber 7. Append 8. Byte Counter 9. Slow List/Stop List *03504, Apple II tape, $29.95*

FLASH & CRASH SOUND EFFECTS (American Micro Products) A collection of 18 subroutines that can be incorporated into your own programs to produce sound effects with the American Micro Products music board. Included are: Train, Explosion, Phaser, Chimes, Sirens, Jet and 12 others. *08709, APPLE II Disk, $39.95*

6502 DISASSEMBLER (Stamm) Produce assembly language source files with labeled subroutines and references from programs already in memory. It is compatible with Hayden's ASSEMBLY LANGUAGE DEVELOPMENT SYSTEM. *08609, APPLE II Disk, $34.95*

PSEUDODISK (Neuschatz) This money-saving program simulates a disk memory system for Integer BASIC programs. It allows multiple programs in memory at the same time which can be run from a catalog. *04804, APPLE II tape, $24.95*

LINE & VARIABLE CROSS REFERENCE GENERATOR (Johnson) Provides a cross-reference of line numbers and variable names. *07301, PET tape, $16.95*

DISK CATALOGER (LeBar) Automatically maintains a cross-reference listing of all your programs, their location by disk number, their function and use. Catalogs, lists and sorts programs. *05203, TRS-80 Level II tape, $16.95; 05208, TRS-80 Level II Disk, $21.95*

APPLE™ ASSEMBLY LANGUAGE DEVELOPMENT SYSTEM: An Assembler/Editor/Formatter (Lutus) Write and modify your machine language programs quickly and easily. *04609, Apple II Disk Version, $39.95*

SUPER APPLE™ BASIC (Lutus) A structured BASIC that compiles into an optimized Applesoft or Integer BASIC program. *05409, Apple II Disk, $39.95*

MAILING LIST (Tru-Data Software) Lists addresses, prints labels, allows for alterations and deletions, and has the capacity to make duplicate data file disks. Can only be used with version 1.5. *05713, Heath tape, $49.95*

FINPLAN: A Financial Planning Program for Small Business (Montgomery) Allows you to enter data from a balance sheet into the program, to make assumptions about future growth of business, and to have the computer project results for up to a five-year period based on those assumptions. And if you change any data, the program revises all resulting data automatically. The disk version can only be used with TRSDOS Version 2.3. *05103, TRS-80 Level II tape, $69.95; 05108, TRS-80 Level II Disk Version, $74.95*

DATA MANAGER: A Data Base Management System and Mailing List (Lutus) Store information on a floppy disk, and retrieve it quickly and easily by specific names, or by category. *04909, Apple II Disk Version, $49.95*

MCAP: A Microcomputer Circuit Analysis Program (Savon) Performs a linear voltage, impedance, or transfer impedance analysis of an electronic circuit. *04501, PET; 04503, TRS-80 Level II; 04504, Apple II; each tape $24.95; 04513, Heathkit/Zenith Disk, $29.95*

MICROCOMPUTER AIDED DESIGN OF ACTIVE FILTERS (Gilder) Eight programs that simplify the design of active filters and will calculate the component values needed for various bandpass, low-pass, and notch-type filters. *01401, PET; 01403, TRS-80 Level II; 01404, Apple II; 01407, Heath; each tape $16.95; 01413, Heathkit/Zenith Disk Version, $21.95*

DISK CERTIFIER AND COPIER (Jacc Inc.) A handy utility program that certifies the acceptability of blank diskettes and rejects those with flaws. It also includes a fast machine language disk copying program that will work on single and dual drive systems. *07809, APPLE II Disk, $19.95*

SONGS IN THE KEY OF APPLE (Lopatin) Allows you to see and hear your favorite tunes, preprogrammed tunes or music you create (up to 200 notes, including rests, per musical piece). *03304, Apple II tape, $10.95*

HOW TO BUILD A COMPUTER-CONTROLLED ROBOT (Loofbourrow) Contains 5 control programs that consist of: Joystick Control Program; Self-Direction Program; Impact Sensor Control Routine; and more. *00100, KIM-1 tape, $14.95* Should be used with text **HOW TO BUILD A COMPUTER-CONTROLLED ROBOT,** *5681 8, $9.75*

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ORDERING INFORMATION

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☐ 01404	☐ 02601	☐ 03408	☐ 03484	☐ 04609	☐ 05208	☐ 08609
☐ 01407	☐ 02701	☐ 03409	☐ 03504	☐ 04804	☐ 05308	☐ 08709
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Forcing the Z80 Starting Address

Randy Soderstrom, 1201 W Valencia Apt 224, Fullerton CA 92633

Late in the design phase of my homebrew Z80 microprocessor-based system I realized there would be a problem in bringing the system up. My monitor program was in ROM (read-only memory) and was written to begin at hexadecimal page F0, character 00. My programmable memory began at page 00, character 00, and to further complicate matters, my system had no front panel.

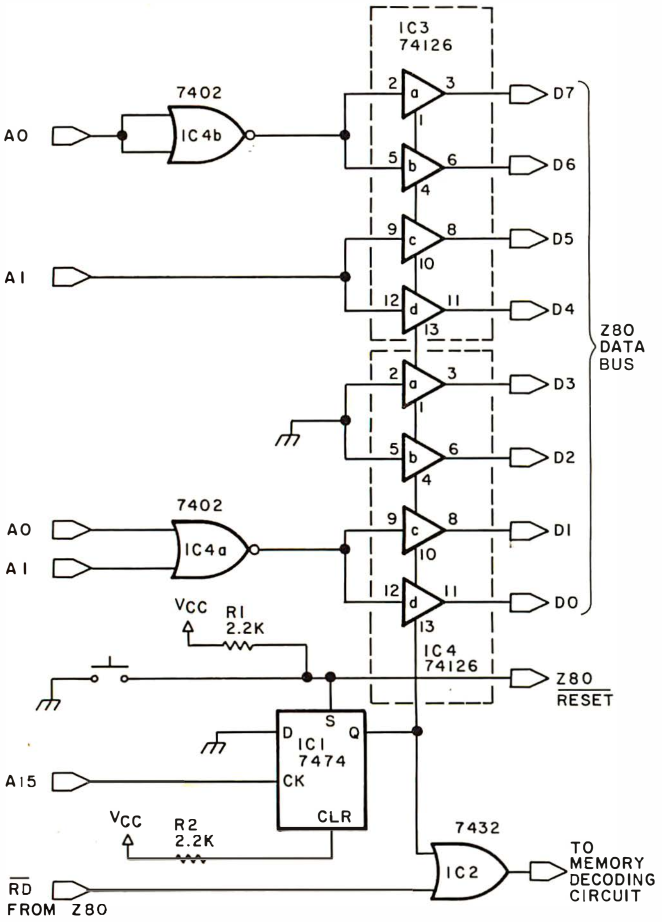


Figure 1: *This circuit will force a Z80 microprocessor to begin execution at hexadecimal page F0, character 00, instead of page 00, character 00. The circuit can be easily modified to begin execution at other addresses.*

I faced a number of problems in order to get the processor to begin execution at page F0. When the Z80 reset line was enabled, it zeroed the program counter, causing execution to begin at location 00. Since the interrupt mode was unpredictable on power up, it was no help either.

After some thought, I came up with the circuit shown in figure 1. When the Z80 reset line goes low, the circuit prevents the memory from being enabled. Instead, machine code is generated for a jump to the start of the program monitor.

When the reset switch is pushed, flip-flop IC1 (integrated circuit 1) is set. This makes the output of OR gate IC2 high, no matter what happens with the processor RD line. Any memory-read operations are inhibited and the IC3 buffers are activated.

While all of this is happening, the Z80 is clearing the program counter and will begin execution on page zero at location 00. However, when the Z80 pulses the RD line low, the OR gate (IC2) blocks it, and no memory data is placed on the bus.

The IC4 NOR gates decode the address, which in this case is 00, and place hexadecimal C3 on the data bus. Since this is the machine code for a jump instruction, it is executed as such.

Next, the processor expects to find the low bits of the branch address. Address 01 is decoded to address 00 and is placed on the data bus. It will be used as the eight low-order bits of the branch address.

Finally, the Z80 places 02 on its address bus and expects the eight high-order bits of the branch address on the data bus. Gates IC4 place hexadecimal F0 on the system data bus. After this byte is read, the Z80 executes the entire instruction and jumps to page F0, character 00.

Because of the jump, address bit A15 goes from low to high, clocking a zero into the flip-flop. This change disables the buffers and restores the system to its normal state.

The Z80's refresh cycle does not interfere with the circuit. The refresh register operates only on A0 through A6.

If you require a more complex initialization, this same concept can be used with a ROM (read-only memory) placed on the bus rather than gates. Done in this manner, the memory space becomes free for other uses after initialization. ■

Software Received

The following is a list of software packages that have been received by BYTE Publications during the past month. The list is correct to the best of our knowledge, but it is not meant to be a full description of the product or the forms in which the product is available. In particular, some packages may be sold for several machines or in both cassette and floppy-disk format; the product listed here is the version received by BYTE Publications.

This is an all-inclusive list that makes no comment on the quality or usefulness of the software listed. We regret that we cannot review every software package we receive. Instead, this list is meant to be a monthly acknowledgment of these packages and the companies that sent them. Companies sending software packages should be sure to include the list price of the packages and (where appropriate) the alternate forms in which they are available.

Apex, disk operating system for the Apple II. Floppy disk, $99. Apparat Inc, 4401 S Tamarac Pky, Denver CO 80237.

Apple Assembly-Language Development System, a 6502 assembler/editor for the Apple II. Floppy disk, $39.95. Hayden Book Company Inc, 50 Essex St, Rochelle Park NJ 07662.

Asteroid, graphics game for the Apple II. Floppy disk, $20. Adventure International, POB 3435, Longwood FL 32750.

Communications Software for the RS-232C, utility program for the transmission of data over telephone wires. Cassette, $29.95. Radio Shack, 1 Tandy Ctr, Fort Worth TX 76102.

Concentration, graphics game with sound for the TRS-80. Cassette, $9.95. Adventure International (see above).

Data Manager, data base system for the Apple II. Floppy disk, $49.95. Hayden Book Company Inc (see above).

Dogfight, graphics game for the Apple II. Floppy disk, $29.95. Micro Lab, 811 Stonegate Dr, Highland Park IL 60035.

FINPLAN, a small business financial planning program for the TRS-80. Floppy disk, $74.95. Hayden Book Company Inc (see above).

Generate, a TRS-80 program generator. Floppy disk, $100. DataWorks Inc, 97 Jackson St, Cambridge MA 02140.

Interactive Fiction—His Majesty's Ship Impetuous, role-playing game for the TRS-80. Floppy disk, $19.95. Adventure International (see above).

Interactive Fiction—Local Call for Death, role-playing game for the TRS-80. Floppy disk $19.95. Adventure International (see above).

Interactive Fiction—Six Micro Stories, role-playing game for the TRS-80. Floppy disk, $14.95. Adventure International (see above).

Interactive Fiction—Two Heads of the Coin, role-playing game for the TRS-80. Floppy disk, $19.95. Adventure International (see above).

Magician's Hat, a game program for the Commodore PET/CBM. Floppy disk, $25. Southern Software Ltd, 100 Anzac Ave, POB 8683, Auckland, New Zealand.

Micro Music Audio Sampler, music composer package for the Apple II. Cassette, $5. Micro Music Inc, POB 386, Normal IL 61761.

Microtyping, touch-typing tutorial program for the Apple II. Cassette $10.95. Hayden Book Company Inc (see above).

Musical Yat-C, strategy game for the TRS-80. Cassette, $9.95. Adventure International (see above).

Software Received

PECA—Passive Electronic Circuit Analysis, electronic design utility program for the TRS-80. Cassette, $19.95. Adventure International (see above).

Pen BASIC, machine-language utility for Photo-point Light Pen and TRS-80. Cassette, $14.95. Micro Matrix, POB 938, Pacifica CA 94044.

PseudoDisk, a disk simulator for Apple II Integer BASIC. Cassette, $24.95, Hayden Book Company Inc (see above).

Royal Flush, poker solitaire game for the Commodore PET/CBM. Cassette, $14.95. Hayden Book Company Inc (see above).

Royal Flush, poker solitaire game for the TRS-80. Cassette, $14.95. Hayden Book Company Inc (see above).

Scramble, word-guessing game with sound for the TRS-80. Cassette, $9.95. Adventure International (see above).

Shark Attack, game for the TRS-80. Cassette, $7.95. Adventure International (see above).

Slag, multiplayer graphics game for the TRS-80. Cassette, $14.95. Adventure International (see above).

Spelling, educational graphics game for the Apple II. Floppy disk, $21.95. Software by Witzel, 7778 S Poplar Way E, Englewood CO 80112.

Star Trek 3.5, graphics game with sound for the TRS-80. Floppy disk, $19.95. Adventure International (see above).

TRS-80 Opera, music-playing program for the TRS-80. Cassette, $9.95. Adventure International (see above).

Tunnels of Fahad, graphics "chase" game for the TRS-80. Cassette, $9.95. Adventure International (see above).

Word Challenge, game with sound effects for the TRS-80. Cassette, $9.95. Adventure International (see above).

Z-Chess III, chess-playing program for the TRS-80. Cassette, $24.95. Adventure International (see above).

Zossed in Space, space exploration for the TRS-80. Cassette, $14.95. Adventure International (see above).■

BYTE's Bits

Call for Papers

The 1981 ACM Annual Conference is soliciting papers for its annual conference to be held November 9-11 in Los Angeles. Technical papers should focus on innovations or recent advances and should emphasize the connection between theory and applications. Suggested topics include operating systems, programming languages, data base systems, artificial intelligence, business data processing, software engineering, project management, personal computing, office automation, distributed systems, computer networks, computer graphics, and simulation.

Authors of papers or surveys must submit four copies of the work, typed and double-spaced, not exceeding twelve pages in length. The deadline for submission is March 7, 1981. Notification of acceptance or rejection is by May 1, 1981. Mail submissions to ACM 81—Call for Papers, Village Sta, POB 24059, Los Angeles CA 90024.■

A Message to our Subscribers

From time to time we make the BYTE subscriber list available to other companies who wish to send our subscribers promotional material about their products. We take great care to screen these companies, choosing only those who are reputable, and whose products, services, or information we feel would be of interest to you. Direct mail is an efficient medium for presenting the latest personal computer goods and services to our subscribers.

Many BYTE subscribers appreciate this controlled use of our mailing list, and look forward to finding information of interest to them in the mail. Used are our subscribers' names and addresses only (no other information we may have is ever given).

While we believe the distribution of this information is of benefit to our subscribers, we firmly respect the wishes of any subscriber who does not want to receive such promotional literature. Should you wish to restrict the use of your name, simply send your request to BYTE Publications Inc, Attn: Circulation Department, 70 Main St, Peterborough NH 03458. Thank you.



Send $3.00 for 11×14 reprint to: P. O. Box 801, La Canada, CA 91011 ©Robert Tinney Graphics 1980

Books Received

An Age of Innovation, by the Editors of *Electronics*. New York: McGraw-Hill Publications Company, 1981; 22 by 29 cm (8½ by 11¼ inches), 267 pages, hardcover, ISBN 0-07-606688-6, $18.50.

Computers and Education, James L Poirot. Manchaca TX: Sterling Swift Publishing Company, 1980; 13.5 by 21 cm (5¼ by 8¼ inches), 84 pages, softcover, ISBN 0-88408-137-0, $6.95.

Computer Graphics Primer, Mitchell Waite. Indianapolis IN: Howard W Sams & Company Inc, 1979; 14 by 22 cm (5½ by 8½ inches), 173 pages, softcover, ISBN 0-672-21650-7, $12.95.

CRT Controller Handbook, Gerry Kane. Berkeley CA: Osborne/McGraw-Hill, 1980; 18 by 23.5 cm (6⅞ by 9⅛ inches), 206 pages, softcover, ISBN 0-931988-45-4, $6.99.

Electrical and Electronics Drawing, fourth edition, Charles J Baer and John R Ottaway. New York: Gregg Division of the McGraw-Hill Book Company, 1980; 16.5 by 24.5 cm (6½ by 9½ inches), 432 pages, hardcover, ISBN 0-07-003010-3, $16.25.

Machine Independent Organic Software Tools (Mint), M D Godfrey, H J Hermans, D F Hendry, and R K Hessenberg. New York: Academic Press, 1980; 15.5 by 23 cm (5⅞ by 9 inches), 340 pages, hardcover, ISBN 0-12-286980-X, $28.

Microcomputer Primer, Mitchell Waite and Michael Pardee. Indianapolis IN: Howard W Sams & Company Inc, 1980; 14 by 22 cm (5⅜ by 8½ inches), 367 pages, softcover, ISBN 0-672-21653-1, $11.95.

Microcomputer Systems and Apple BASIC, James L Poirot. Manchaca TX: Sterling Swift Publishing Company, 1980; 13.5 by 21 cm (5¼ by 8¼ inches), 136 pages, softcover, ISBN 0-88408-136-2, $9.95.

Owning Your Home Computer, Robert L Perry. New York: Everest House Publishers, 1980; 18.5 by 25.5 cm (7¼ by 10 inches), 200 pages, softcover, ISBN 0-89696-093-5, $10.95.

Programming & Interfacing the 6502, With Experiments, Marvin L De Jong. Indianapolis IN: Howard W Sams & Company Inc, 1980; 14 by 22 cm (5½ by 8½ inches), 407 pages, softcover, ISBN 0-672-21651-5, $15.95.

Radar & Radio Communications IC Handbook, Plessey Semiconductors. Irvine CA: Plessey Semiconductors, 1980; 14 by 22 cm (5½ by 8½ inches), 436 pages, softcover ISBN-none, $4.

Son of Cheap Video, Don Lancaster. Indianapolis IN: Howard W Sams & Company Inc, 1980; 14 by 22 cm (5½ by 8½ inches), 220 pages, softcover, ISBN 0-672-21723-6, $8.95.

Teams in Information Systems Development, Philip C Semprevivo. New York: Yourdon Press, 1980; 15.5 by 23 cm (6 by 9 inches), 126 pages, softcover, ISBN 0-917072-20-0, $16.75.

Using CP/M, Judi N Fernandez and Ruth Ashley. Somerset NJ: John Wiley & Sons Inc, 1980; 17.5 by 25.5 cm (6¾ by 10 inches), 236 pages, softcover, ISBN 0471-08011-X, $8.95. ■

This is a list of books received at BYTE Publications during this past month. Although the list is not meant to be exhaustive, its purpose is to acquaint BYTE readers with recently published titles in computer science and related fields. We regret that we cannot review or comment on all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.

Clubs and Newsletters

Pascal/Z Users Group

The purpose of the Pascal/Z Users Group is to spread the application and use of the Pascal language. The group is offering four disks of public-domain software applicable to Z80 and Pascal/Z systems. The floppy disks cost $10 each; membership in the group is not required for purchase. The programs are in source code and in a COM file. They include tutorials, utilities, and various applications. The group is continually seeking quality software from programmers. A bimonthly newsletter is available for $6 per year. Additional details can be obtained by writing the Pascal/Z Users Group, 7962 Center Pky, Sacramento CA 95823.

I-SUG

This group has been organized as a co-op to enable Exidy Sorcerer users to gain access to a mailing list and a user-contributed library. The library contains programs and other technical information for the Sorcerer. I-SUG charges neither fees nor membership dues. Clubs and individual Sorcerer users are encouraged to use I-SUG to contact other clubs and attract new members. For complete details, send a self-addressed, stamped envelope to I-SUG, POB 1542, St Catharines, Ontario, L2R 7J9, Canada.

Pocket Computer Newsletter

The Pocket Computer Newsletter reports on the latest developments concerning pocket and hand-held computers. Published ten times a year, the newsletter also features programming tips, operating time-savers, tutorial articles, notes on customizing units, programming shortcuts, listings of programs, technical information, application forums, and product reviews. The subscription price is $20 in the US, $24 in Canada, and $30 elsewhere. For information, contact *The Pocket Computer Newsletter*, POB 232, Seymour CT 06483.

Monroeville Apple Users Club

This club has just recently formed. If you would like more information, write to the Monroeville Apple Users Club, attn: Dr G J Harloff, 579 Carnival Dr, Pittsburgh PA 15239.

The Cursor Group

The Cursor Group is a manufacturer-supported user group for the Bally Arcade that supports over forty affiliated local users groups. The Bally Arcade employs an enhanced version of Palo Alto Tiny BASIC, which includes analog-to-digital con-

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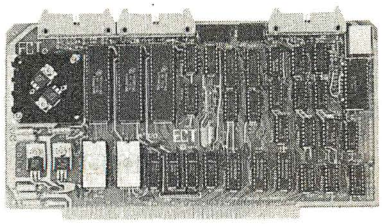
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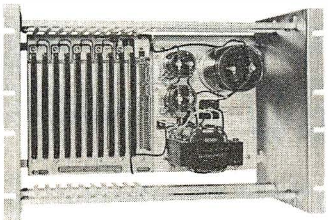
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version, a three-voice music synthesizer, 156 by 128 resolution with up to 256 colors, and user-accessible graphics. Commands and routines not included in the documentation are published in the group's newsletter, *The Cursor*. Other manuals are being published. Contact The Cursor Group, POB 266, North Hollywood CA 91603.

SD User Exchange

SD User Exchange is a dealer group designed to meet the needs of the SD dealer. The group's goal is to provide an avenue for the exchange of software programs, technical knowledge, marketing tools, and ideas among SD dealers. This group was recently formed, so if you would like to become a part of this growing pool of SD resources, contact SD Systems, 3401 W Kingsley Rd, Garland TX 75041, or call Bob Sherman, Director of Marketing, at (214) 271-4667.

Newsletter for Home Computer Users

Home Computers is a brand-new newsletter for hobbyists, investors, and the small-business person. The publication is written for home computer users who use their machines for taking inventory of collections or products, investment analysis, bookkeeping, and educational and recreational game playing. *Home Computers* contains equipment reviews, programming methods, a forum for input standards, coding for specific functions, and a primer for beginning programmers. Subscription information can be obtained by sending a self-addressed, stamped envelope to *Home Computers*, POB 616, Silverton OR 97381.

SuperLetter!

SuperLetter is for SuperBrain users. Subscribers will be able to keep pace with the latest technical news, operating tips, accessory ideas, and software designs for Intertec's machine. Regular monthly features include a technical corner, a question-and-answer forum, the latest-breaking news from the factory, guest interviews, and the SuperClassifieds. *SuperLetter* inquiries can be addressed to Abrams Creative Services, 369 S Crescent Dr, Beverly Hills CA 90212, (213) 277-1588.

PET Users Group

At 7:30 PM on the second Tuesday of the month, you can find the NW PET Users Group meeting in the University of Washington's Academic Computer Center, 3737 Brooklyn, in Seattle, Washington. This group is dedicated to the use of PET/CBM microcomputers. The NW PET Users Group publishes a newsletter on a semiregular basis and it occasionally charges membership dues. Contact Richard Ball, 2565 Dexter N # 203, Seattle WA 98109, (206) 284-9417, for complete information.

Club in Venezuela

Civil Engineering students and professors at the University of Carabobo, Valencia, Venezuela, have formed a computer club. The Club de Computación Lampas de Carabobo meets on the first and second Tuesdays of each month. The primary interest is in the application of microcomputers to civil engineering practice and teaching, including basic sciences as well as administrative and technical aspects. Write to the club at Apartado 716, Valencia, Venezuela, 2001A.■

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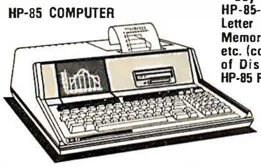
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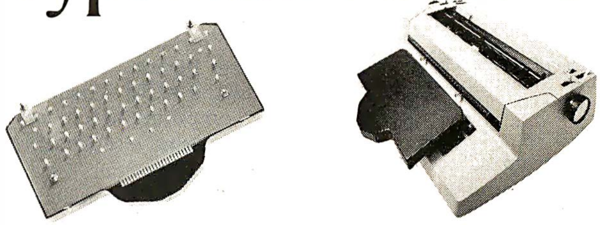
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Event Queue

February 1981

February-May
Courses from ICS, various cities throughout the US. ICS (Integrated Computer Systems) is presenting a series of intensive 3- and 4-day courses on computerized robots; interactive computer graphics; programming in Ada; structured design and programming; microprocessor software, hardware, and interfacing; computer network design and protocols; and many other topics. Contact ICS, 3304 Pico Blvd, POB 5339, Santa Monica CA 90405, (800) 421-8166; in California (800) 352-8251.

February-May
Greater Boston Area ACM Lectures, the Mitre Corporation, Bldg J, Middlesex Tpke, Burlington MA. The Greater Boston Area Chapter of the ACM (Association for Computing Machinery) is sponsoring a series of lectures ranging from "Cryptography and Computer Security" and "Software Tools" to "The Future of Data Base Systems" and "Computer Simulation." For a schedule of times and lecture fees, contact the Greater Boston Chapter of the ACM, POB 465, Lexington MA 02173.

February-June
The Hartford Graduate Center, Winter—Spring Courses, The Hartford Graduate Center, 275 Windsor St, Hartford CT 06120. A listing of courses from the Hartford Graduate Center is available by calling (203) 549-3600, ext 252, or by writing Don Florek at the center. The courses offered cover hardware and software topics, along with management and theory studies.

February 9-10
Applying Single-Chip Microcomputers, Hyatt Regency Cambridge, Cambridge MA. This seminar is designed to help anyone with a basic working knowledge of computer hardware. It is being sponsored by *Electronics* . The fee is $445. Contact Barbara Bancroft, c/o McGraw-Hill Seminar Center, 305 Madison Ave, Rm 3112, New York NY 10017, (212) 687-0243.

February 9-13
Reliability Engineering, Testing and Maintainability Engineering, University of California, Los Angeles CA. This course is geared for engineers specializing in reliability, product assurance, logistics, quality assurance, and product design, and is designed for those who design and predict the reliability of components, equipment, and systems. The course fee is $750. Contact Continuing Education in Engineering and Mathematics, UCLA Extension, POB 24901, Los Angeles CA 90024, (213) 825-1047.

February 14-16
International Conference on Microcomputer Applications to Industrial Controls, Jadavpur University, Calcutta, India. Papers will be presented on the applications of microcomputers to industrial controls in the areas of general systems. Contact Dr Sushil Dasgupta, Professor and Head, Electrical Engineering Department, Jadavpur University, 40B, Southern Ave, Calcutta-700029, India.

February 17-18
Integrating Word Processing and Electronic Data Processing: Technology, Architecture, Planning, The Harvard Club, New York NY. The topics of this seminar will be the study of word processing today and its future, the evaluation and selection of systems, electronic mail and communications, and the automated office. For further details, contact the seminar coordinators at the Center for Management Research, 850 Boylston St, Chestnut Hill MA 02167, attn: Ms Karen Smolens, (617) 738-5020.

February 18-20
Business- and Personal-Computer Sales and Exposition and the Houston Business Show, Houston Civic Center, Capitol Ave and Bagby St, Houston TX. Data-processing managers, systems analysts, programmers, educators, hobbyists,

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February 23-26
Computer Science Conference, Stouffer's Riverfront Towers Hotel, St Louis MO. The conference is sponsored by the ACM (Association for Computing Machinery). The Ninth Annual Computer Science Employment Register will be conducted. This register aids in matching computer scientists and data-processing specialists with employer opportunities. For information, contact Orrin E Taulbee, ACM Computer Science Employment Register, Department of Computer Science, University of Pittsburgh, Pittsburgh PA 15260, (412) 624-6475.

February 24-25
The Ninth Annual Midwest Digital Equipment Exhibit and Seminar, Thunderbird Motel, Minneapolis MN. More than sixty manufacturers of computer terminals, data-communication equipment, peripherals, and test instruments will be displaying their products. Over 1500 users and manufacturers are expected to attend. Registration at the entrance area is required, but there is no charge to attend exhibits or seminars. Contact Kim Shobe, c/o Loonam Associates Inc, 7720 Bush Lake Rd, Minneapolis MN 55435, (612) 831-1616.

February 26-27
Louisiana Computer Exposition, University of Southwestern Louisiana, Lafayette LA. Papers will be read on operating systems, data-base management and support, distributed computers systems, and related topics. Contact William R Edwards, c/o the Computer Science Department, University of Southwestern Louisiana, POB 44330, Lafayette LA 70504, (318) 264-6284.

March 1981

March-November
Advanced Data Processing Workshops, Deltak Inc, various cities throughout the US and Canada. These 5-day workshops are aimed at data-processing training managers responsible for the management and administration of data-processing training and involved in planning, monitoring, evaluating, and reporting to upper management on the status of the training. For a schedule of dates and locations, contact Deltak Inc, 1220 Kensington Rd, Oak Brook IL 60521, (312) 920-0700.

March 8-11
TI-MIX 1981, Marriott Hotel, New Orleans LA. This is a conference for Texas Instruments equipment users. Thirty-six sessions consisting of individual presentations, panel discussions, and workshops are planned. Two exhibit rooms featuring the latest computer equipment from Texas Instruments will be open. Contact TI-MIX, M/S 2200, POB 2909, Austin TX 78769, (512) 250-7151.

March 11-13
Business- and Personal-Computer Sales and Exposition and New York Business Show, Madison Square Garden, New York NY. See February 18-20 for details.

March 17-20
The Fourteenth Annual Simulation Symposium, Tampa FL. Papers describing digital discrete simulation and other techniques will be read. This symposium is a

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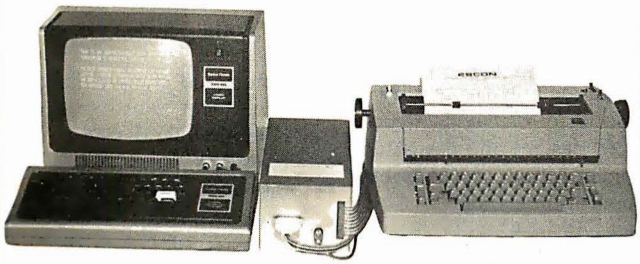
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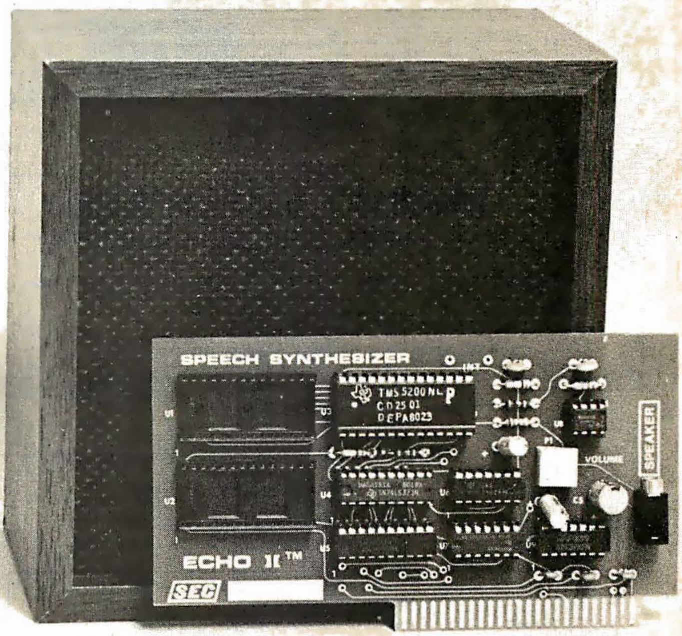
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forum for the exchange of ideas and techniques in computer simulation. Contact Annual Simulation Symposium, POB 22621, Tampa FL 33622.

March 20
Digital Computer Association Annual Meeting, Pacifica Hotel, 6161 Centinela Blvd, Culver City CA. Cocktails, dinner, and the annual meeting are the features of this gathering. For more information, contact Mary Rich, 731 Bayonne St, El Segundo CA 90245.

March 23-25
Office Automation Conference, Albert Thomas Convention Center, Houston TX. This conference will present seminars on concepts and methods behind the latest office technologies and an exhibition of office equipment. Contact Office Automation Conference, POB 9659, Arlington VA 22209, (703) 558-3617.

March 24-26
The Southwest Semiconductor Exposition, Phoenix Civic Plaza Convention Center, Phoenix AZ. More than 140 equipment and materials makers will exhibit semiconductor, hybrid, and printed-circuit board production, processing, and test equipment. Contact Cartlidge & Associates Inc, 491 Macara Ave, Suite 1014, Sunnyvale CA 94086, (408) 245-6870.

March 31-April 2
Cincinnati Business Show, Cincinnati Convention-Exposition Center, Cincinnati OH. Office equipment and services, including automated systems, communications, computers, telephone systems, word processing, data processing, printing equipment, and other office supplies, will be featured. A program of business seminars is also scheduled. Contact Ray G Nemo, 5679 Creek Rd, Cincinnati OH 45242, (513) 531-5959.

April 1981

April 1-3
Assuring Quality in Electronic Data Processing Applications, McCormick Inn Hotel, Chicago IL. The objective of this conference is to explain the methods, tools, and techniques that are valuable in improving the quality of computerized applications. Tutorials will cover the areas of quality assurance; managing structured design; and designing, implementing, and enforcing application standards. Contact DPMA Quality Assurance Conference, 12611 Davan Dr, Silver Spring MD 20904, (301) 622-0066.

April 3-5
The Sixth West Coast Computer Faire, Civic Auditorium, San Francisco CA. The Faire, a major personal-computing event, has continually attracted larger and larger numbers of exhibitors and attendees. A full program of talks plus a large display of hardware and software are featured. For more information, contact Computer Faire, 333 Swett Rd, Woodside CA 94062, (415) 851-7075.

April 7-8
Top Secrets '81, Pointe Resort, Phoenix AZ. Honeywell's annual computer security and privacy conference. Many authorities in the field of data security will discuss the business and legal impact of the latest incidents in computer crime and abuse. The conference fee is $500. Contact the Security Symposium Registrar, Honeywell Information Systems, M/S T-99-4, POB 6000, Phoenix AZ 85005, (800) 528-5343.

April 7-9
Computerized Office Equipment Expo, O'Hare Exposition Center, Rosemont IL. Over 200 exhibitors will be featuring their office equipment at this show. Executives and administrators from wholesale, retail, commercial, financial, and industrial establishments are invited, along with the general public. Contact Industrial & Scientific Conference Management Inc, 222 W Adams St, Chicago IL 60606, (312) 263-4866.

April 7-9
Electro/81, New York Coliseum and Sheraton Centre Hotel, New York NY. Electro/81 will feature computers and computer-related equipment, plus seminars on components, devices, and materials; computer communications; memories; office automation; speech; and more. Contact Electronic Conventions Inc, 999 N Sepulveda Blvd, Suite 410, El Segundo CA 90245, (213) 772-2965.

April 13-16
The Fifteenth Annual Symposium on Minicomputers and Microcomputers, MIMI '81, Sheraton Hotel, Mexico City, Mexico. This symposium covers hardware, software, distributed processor architecture, computer networks, telecommunications, real-time applications, education, and more. Contact Ing. Jorge Gil, Academic Secretary, MIMI Symposium, IIMAS-UNAM, Apartado Postal 20-726, Mexico 20 D F, Mexico.

April 26-30
Saudibusiness '81, Riyadh, Saudi Arabia. This show has been designed for the fast-growing Saudi Arabian business community. Pavilions by the United States, the United Kingdom, West Germany, France, Italy, and approximately fifteen other countries will be featured. For more information, contact Donald Ryan, Project Manager, Rm 3200, US Department of Commerce, Washington DC 20230, (202) 377-4652. ■

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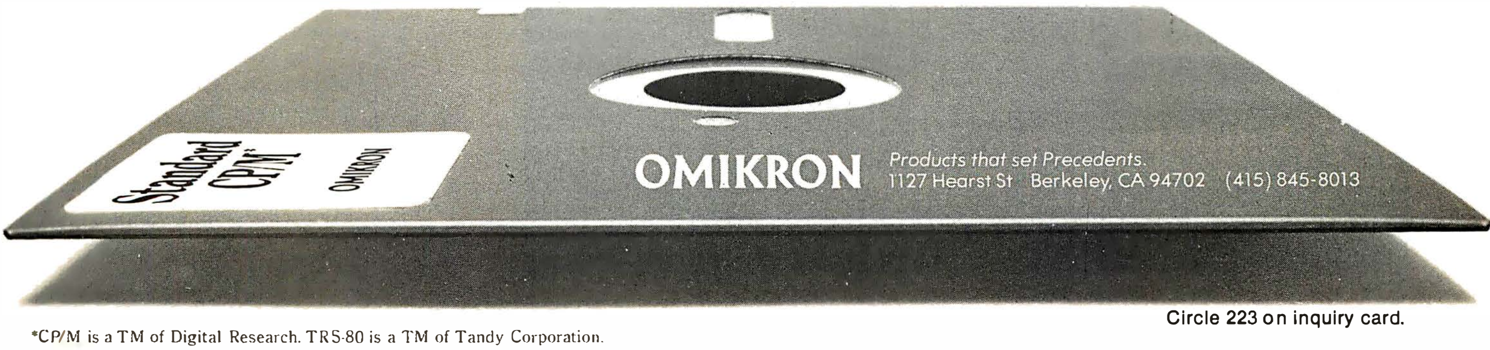
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See review in July 80 BYTE By Jerry Pournelle.



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Writing Interactive Compilers and Interpreters

P J Brown
Wiley Interscience
New York, 1979
256 pages, hardcover
$26.95

Reviewed by
Paul Chisholm
209 Bernard Ct
Madison WI 53715

There are two important aspects of compiler writing. One is that compilers are big programs, and big programs are very difficult to write. (A thousand-line program is considerably more than ten times as difficult to write as a hundred-line program.) The other aspect is that there are many well-known techniques for translating or interpreting programs. Brown's book deals with this aspect. He assumes you are able to program in a high-level language (such as Pascal) and that you have had some experience with an interactive language (preferably BASIC).

Brown discusses the fundamentals of compiler writing. He strongly emphasizes *interactive* programming languages, like BASIC, where programs are developed one segment at a time, as opposed to being carefully edited and put through a compiler. He also assumes that most of his readers are working with single-user microcomputer systems which have limited memory. Therefore, he often mentions ways to squeeze a few extra bytes from the programs; but he does not worry very much about speed.

The book is divided into eight parts. They deal with planning of the project, the overall structure of the compiler (including the internal representation language, error checking, symbol tables, storage management,

and such), the internal language (most often Reverse Polish Notation), parsing and translation, the run time system, other modules, compiler testing, and advanced topics.

Throughout the book, Brown emphasizes the modular approach—designing, coding, and testing the system one piece at a time. He spends much time on the recreation of programs from the internal representation. For instance, if the BASIC you use sometimes inserts or drops spaces in your statements, it is because the editor within the BASIC system does not store your program the way you typed it in. Instead, it stores it in its own internal representation. Unless you also want to store the program exactly as it was entered, using a total of twice as much memory, you need a way to recreate the program from the internal representation. Brown also discusses incremental compiling—compiling a program a segment at a time. (If the version of BASIC you use translates each line as it is typed in, it is doing incremental compilation.) And Brown talks about handling what he calls "break ins"—what must be done after you hit the break or reset key. There is a very complete index, and an excellent bibliography.

Brown does not say much about the other major aspect of compiler writing—how to write very large programs. However, he suggests several "deadly sins" to avoid. He recommends the book *Software Tools*, by Brian Kernighan and P J Plauger, for more on this subject.

If you have had some experience with writing very large programs, *Writing Interactive Compilers and Interpreters* has all you need to know to write a compiler or interpreter that handles BASIC, PILOT, or Logo (or even APL or LISP). It is a little weak for handling more complex languages

such as Pascal. Brown is aware of this, and suggests more advanced readers look at David Gries's *Compiler Construction for Digital Computers*. If you plan to write more advanced compilers, it would be well worth your while to read Gries. However, if you are just starting out writing compilers, P J Brown's book is the one for you.

Language in Thought and Action (4th edition)

S I Hayakawa,
Harcourt Brace Jovanovich
New York, 1978
318 pages, softcover
$8.95

Reviewed by
Thomas Munnecke
6199 Shaker Drive
Riverside CA 92506

At first glance you might wonder what this book by the flamboyant senator from California has to do with computers. Although it is ostensibly a textbook for students of semantics, it is actually a very timely and insightful guide for anyone interested in computer languages, systems design, program documentation, or software engineering.

Written in 1939, before the digital computer was even a dream, *Language in Thought and Action* offers valuable lessons for today's computer-smart reader. Forty-two years after publication, Hayakawa's book seems almost prophetic. Or perhaps our technology has not taken us as far as we would like to believe.

Hayakawa will appeal to anyone interested in logical thought processes and, more particularly, linguistics. He wrote "as a response to the dangers of propaganda, especially as exemplified in Adolf Hitler's success in per-

suading millions to share his maniacal and destructive views. It was my conviction then, as it remains now, that everyone needs to have a habitually critical attitude towards language—his own as well as that of others."

In order to fully appreciate his book, you must transfer the concept of "language" as the spoken word to the concept of "language" as it exists in the computing world. Both have syntax (how you say it), semantics (what you mean), and pragmatics (what you are trying to accomplish). Once you grasp the generality of language, you can understand the concept of computer language. Languages, specifications, and documentation suddenly appear in a new light.

Beginning programmers often seem unable to recognize the arbitrary nature of the symbols in the programming language. It is as if they see the term "SIN(X)" as some kind of magical incantation, rather than as a programmed abstraction of a particular language. Hayakawa's statement on this is as follows:

"We are, as human beings, uniquely free to manufacture and manipulate and assign values to our symbols as we please. Indeed, we can go further by making symbols that stand for symbols."

Although all computer languages manipulate and assign values to symbols, the early computer languages, such as FORTRAN, COBOL, and BASIC, restrict the dynamic manipulation of these symbols. Newer languages have gone further, creating symbols that stand for symbols, as in APL, PL/1, MUMPS, LISP, and Pascal.

For those initially confused by the apparent complexities of higher-level languages, Hayakawa offers this encouragement:

"The fact that more things can go wrong with motorcars than with wheelbarrows is no reason for going back to wheelbarrows. Similarly, the fact that the symbolic process makes complicated follies possible is no reason for wanting to return to a cat-and-dog existence. A better solution is to understand the symbolic process, so that instead of being its victims, we become, to some degree at least, its masters."

He also warns that symbols must be viewed in their relationship to other symbols. I once had an experience with a computer programmed to assist in medical diagnoses. I was asked to type in my symptoms, and the computer would respond with a possible diagnosis. Being on the last leg of a hectic cross-country trip, I selected symptoms of headache, tiredness, and so forth. The computer responded with the suggestion that I was suffering from pre-menstrual tension. It unfortunately ignored the critical context that I was male.

The chapter on "Reports, Inferences, and Judgments" directly corresponds to the chronological development of the computer technology industry. The "report" concept is equivalent to the old batch-run systems in which the entire file is reported to the user after each batch is run. Many of these systems are being reprogrammed to run on-line with the manipulation of only selected data—in correspondence to Hayakawa's "inference." And finally, the "judgment" concept applies to the use of the computer in the future, as it becomes actively involved in making its own decisions in such disciplines as artificial intelligence or modeling.

Hayakawa then turns to a discussion about standards. He cites the chaos existing in the time zone standards before the year 1883:

"When it was noon in Chicago, it was 12:31 in Pittsburgh, 12:24 in Cleveland, 12:17 in Toledo....There were twenty-seven time zones in Michigan alone. (When the time zones were standardized, farmers were afraid of the change, saying that their cows would not know when to come home.)"

The comparison with computer language standards is clear. How many BASIC and Pascal dialects and extensions are there? And how many interpretations of the S-100 bus are floating around? When it comes to getting modern-day language implementors to agree on a standard version, one meets just as many sacred cows.

His section "Presymbolic Language in Ritual" could just as well have been discussing the ritualistic statements forced upon the COBOL programmer every time he writes a program. A strong comparison could be made between this meaningless process in COBOL and the multitude of religions around the world which conduct services in old and forgotten languages.

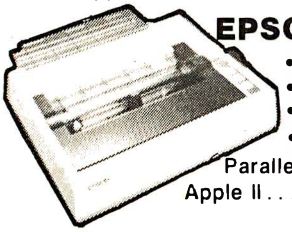
In "How We Know What We Know," Hayakawa explains the process of abstracting. He takes us from a quote by Ambrose Bierce:

"An edible: Good to eat and wholesome to digest, as a worm to a toad, a toad to a snake, a snake to a pig, a pig to a man, and a man to a worm...."

to an exposition of the levels of abstraction of a cow, in an essay that should be required reading for all programmers who strive for structured programming or structured design.

The section "On Definitions" should be read by anyone who is too impressed by program documentation outside the program:





"Definitions, contrary to popular opinion, tell us nothing about things....That is, when we stay at the same level of abstraction in giving a definition, we do not give any information, unless, of course, the reader is already sufficiently familiar with the defining words to work himself down the abstraction ladder."

The concept of "Dead-Level Abstracting" describes the person who is permanently stuck at a certain level on the abstraction ladder. Hayakawa defines the two extremes—the low-level, who "go on indefinitely, reciting insignificant facts, never able to pull them together..." and the high-level, whose language "remains permanently in the clouds." These extremes describe two personalities often found in computer-related environments. The low-level personality is typified by a COBOL programmer, determined never to learn another language because he already "knows how to program." The high-level person is apt to be a systems analyst who dreams of computing the world. These two approaches to systems design could be called "bottom down" and "top up," respectively.

The sections "Confusion of Levels of Abstraction," "Classification," "The Blocked Mind," and "Cow_1 is not Cow_2" will capture the sympathy of anyone who has grappled with the problems of systems design. "The Two-Valued Orientation" could have been written by someone criticizing the computer's ruthless binary decision-making process.

Today, "Poetry and Advertising" could easily be renamed "Poetry and Programming." Hayakawa's phrase, "Advertising is a symbol-manipulating occupation," is reminiscent of Frederick Brooks's approach in his excellent book about computer programming, *The Mythical Man-Month:*

"The programmer, like the poet, works only slightly removed from pure thought-stuff. He builds castles in the air, from air, creating by the exertion of the imagination. Few media of creation are so easy to polish and rework, so readily capable of realizing grand conceptual structures."

This analogy might help explain the programmer's personality to outsiders.

Perhaps the most meaningful summary of the book is Hayakawa's own. In his section "Rules for Extensional Orientation," he writes:

" 1. A map is NOT the territory it stands for; words are NOT things.
2. The meanings of words are not in the words; they are in us.
3. Contexts determine meaning.
4. When tempted to 'fight fire with fire' remember that the fire department usually uses water.
5. The two-valued orientation is the starter, not the steering apparatus.
6. Beware of definitions, which are merely words about words."

All in all, this is an insightful book on language in action. ■

BYTE's Bits

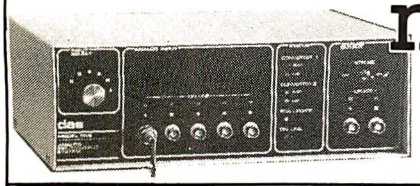
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A/D and D/A Conversion— An Inexpensive Approach

Roger W Mikel
5504 Thomas Ln
Ft Worth TX 76114

Although there are many ways to achieve the conversion of data from analog to digital form, a converter that is simple, fast, inexpensive, and reasonably accurate is seldom available to the serious experimenter. Here I will describe a design that fulfills these characteristics.

To be of practical use, a converter should have at least 8 bits of resolution and be accurate to 0.4% (the value of the least significant bit). In most cases, the conversion should be complete in 10 to 20 μs; this is about as fast as most microprocessors can collect two measurements and do anything with them.

Theory

After ruling out V/F (voltage-to-frequency conversion), slope integration, and charge-balancing systems because of their slowness or complexity, I finally decided that the circuit should consist of a counter cycling continuously to drive a D/A (digital-to-analog) resistance ladder, commonly called an R/2R circuit. The ramp signal produced is used as a reference voltage which the analog input signal is compared with.

The output of a comparator may be used to strobe latches that sample the output of the counter. This means that a conversion is completed every 256 clock cycles—at 20 MHz, the conversion takes less than 13 μs.

The Circuit

The clock circuit is based on a K1100A packaged oscillator produced by Motorola, designated as IC1 in figure 1. This particular circuit was chosen primarily because one was on hand. There are a number of other circuits that would work as well, such as a 74123 multivibrator connected in an astable configuration, or an NE555 timer (if speed is not a consideration). For full-speed operation, the clock frequency can be in the range of 20 MHz and should have a clean square-wave output to drive the counter stage properly.

This converter is simple, fast, inexpensive, and reasonably accurate.

The counter stage consists of IC2 and IC3, both 74193 synchronous 4-bit up/down counters. These are designed to switch simultaneously and therefore do not produce the switching transients seen at the outputs of asynchronous ripple counters. Such "glitches" would result in erratic comparator operation.

A second advantage of these devices is that they may be loaded in parallel; this allows us to use the circuit in converting data both to and from digital form. The parallel output from these counters drives the 74173 quad-D latches (IC4 and IC5) as well as the resistance ladder.

The resistance ladder is a network of resistors designed to produce a voltage proportional to the binary number applied. The output voltage that appears at point A in figure 1 is described by equation 1. E0 thru E7 represent the voltages present on the eight counter-output lines. Since the counter output is nominally 5 V, voltages from 20 mV to almost 5 V can be generated in 20 mV increments.

The actual value of R in figure 1 is not too important, and can be anywhere in the range of 5000 to 50,000 ohms. It is important that all resistances in the ladder are closely matched because this will affect the accuracy of the circuit. A good method to ensure close tolerance is to

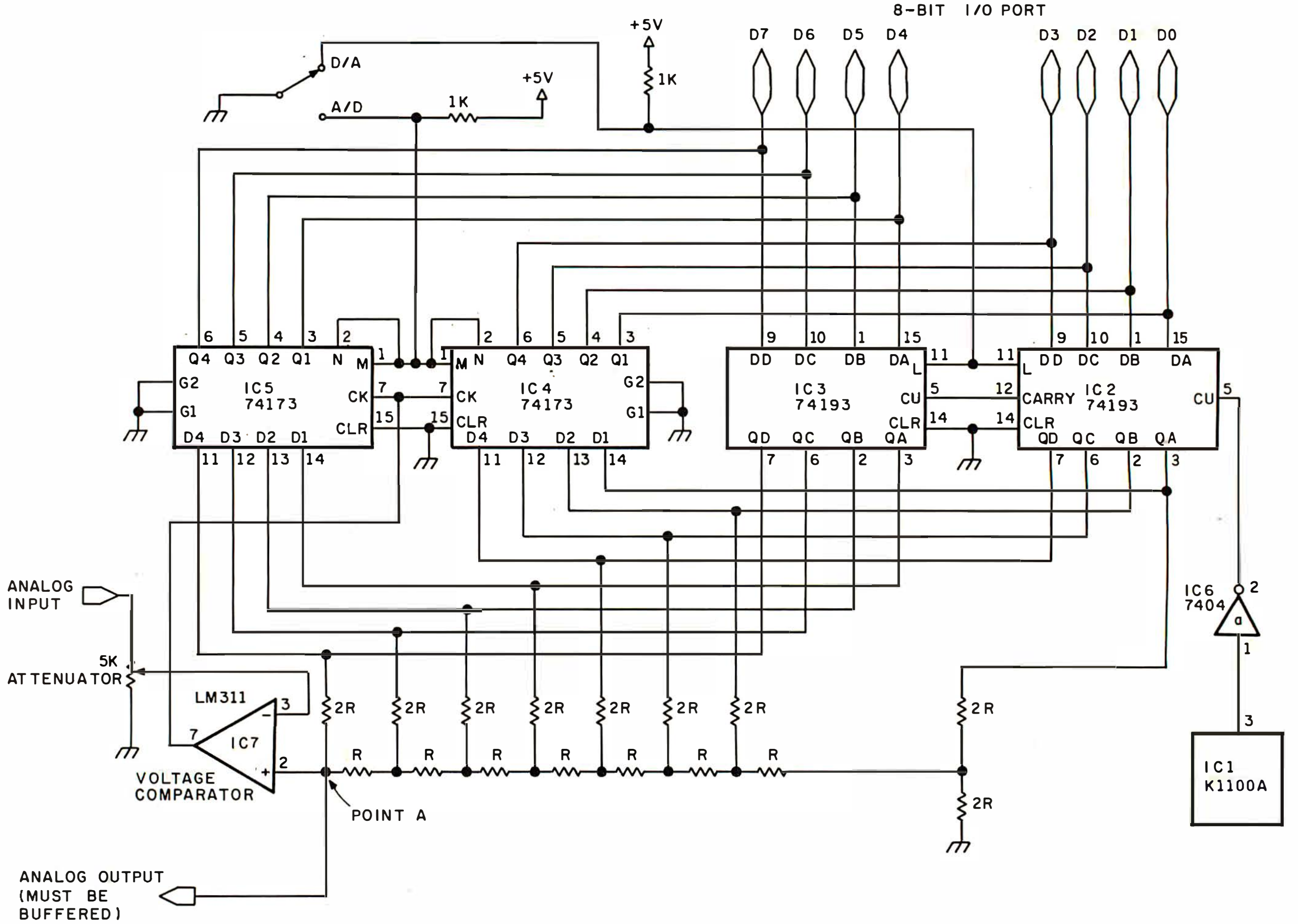


Figure 1: *This schematic diagram shows that a small number of parts (all easily obtainable) can be used for a fast, flexible converter. Operation is switch-selectable for A/D or D/A modes; conversion takes less than 13 µs in A/D mode, and is almost instantaneous in D/A mode. Speed of conversion is set by clock frequency and propagation delays in the integrated circuits used. The concept is easily expandable to 12 or 16 bits, if necessary.*

Number	Type	+5V	GND
IC1	K1100A	1	2
IC2	74193	16	8
IC3	74193	16	8
IC4	74173	16	8
IC5	74173	16	8
IC6	7404	14	7
IC7	LM311	8	1,4

Equation 1

$$\text{Output Voltage} = \frac{E7}{2} + \frac{E6}{4} + \frac{E5}{8} + \frac{E4}{16} + \frac{E3}{32} + \frac{E2}{64} + \frac{E1}{128} + \frac{E0}{256}$$

buy twenty-five resistors of the same value from the same batch, then use two resistors in series for each 2R leg. In the D/A conversion mode, the output, which may be taken from point A, must be buffered, since the counter outputs are of the low-power type.

The voltage comparator (IC7) compares the analog input signal to the output voltage of the resistance ladder. Since the counter increments from zero, the ladder output should start out lower than the analog signal. When the ladder output level is greater than the analog signal, the comparator senses the change and provides a strobe to latch the counter values into IC4 and IC5. A 5 k-ohm potentiometer may be included to attenuate input signals greater than 5 V.

The comparator is an LM311, which was chosen because it requires only a single-ended power supply. This simplifies construction considerably.

The output latches (IC4 and IC5) are a pair of 74123 quad-D flip-flops. They were chosen because of their low drive requirements and their three-state outputs. The output pins may be connected to the parallel inputs of the counter circuit, and their three-state ability allows the use of one port for both input D/A and output A/D (analog-to-digital) operation.

Operation

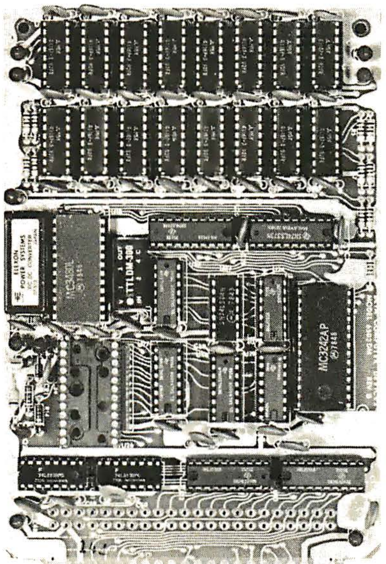
A complete A/D conversion cycle goes as follows (refer to figure 2):

- The cycle starts as the counter goes through hexadecimal 00. The voltage at point A is at zero and the output latch contains the result of the last conversion cycle.
- The counter increments toward hexadecimal FF, and at some

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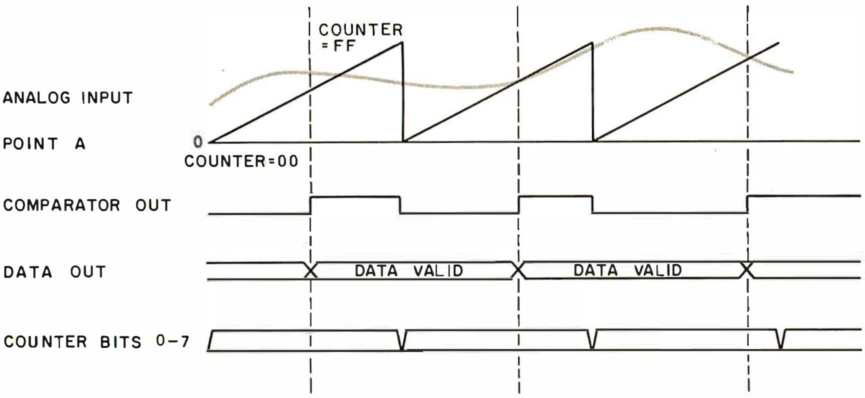


Figure 2: *This timing diagram shows that, when the reference voltage (point A) has reached the level of the analog-input signal, the comparator toggles to strobe the 74173 latches. Data in the latches remains valid until the comparator toggles again.*

point the voltage at point A will be equal to the analog input voltage. At this time, the comparator will drive the clock input (pin 7) to the latches high.

- The rising edge of the pulse will cause the latches to retain the state of the counters at that time.
- This data is retained until the next conversion is finished.

In the A/D mode, the data is applied to the counter inputs with the load pin (pin 11) grounded. This feeds the digital information directly to the resistance ladder, so conversion is immediate.

Construction

As long as component leads are kept short, no special construction practices are required. I believe that wire-wrap is the best way to build such projects. Due to the high speed of the circuit, it is important to bypass each integrated circuit with a 0.1 μF capacitor. I soldered the bypass capacitors directly to the back of the sockets. Any component failures in the bypass network will show up as erratic operation (due to noise).

Application

The A/D operation of the circuit is very simple. Connect the circuit to an 8-bit I/O (input/output) port; when you want a measurement, simply read the value that appears at the port. Operation is similar in the D/A mode; simply write data to the port (with the select switch set to D/A). The analog input signal may range from zero to about 4.5 V (or greater with the optional attenuator). Analog outputs have the same range, unless you take the trouble to install a buffer amplifier.

Of course, the concept is expandable; 12-bit and 16-bit converters are easily possible with a few more components, although conversion times will be longer. ■

Circle 239 on inquiry card.

Turn Your COSMAC VIP into a Frequency Counter

Andrew Modla
5 Derby Pl
Newtown PA 18940

Many electronic construction projects include a decade-frequency counter somewhere in their hardware. For example, I have seen decade-frequency counters in pH meters, digital voltmeters, capacitance meters, tachometers, digital thermometers, camera shutter-speed meters, event counters, etc. This article describes a frequency counter that is somewhere else—in *software*. This application is an example of the elimination of hardware by using software techniques. No additional hardware is required. Your microcomputer can replace decade-counter hardware in each of the construction projects named above.

I programmed my RCA COSMAC VIP microcomputer to perform as a general-purpose, audio-range decade-frequency counter. The program will count in the 1 to 11,004 Hz range. It checks the transitions of the COSMAC 1802 microprocessor EF4 input flag for one second. The binary count taken is then converted to a decimal value for display on the video monitor. After two seconds to show the count, the program begins to count again.

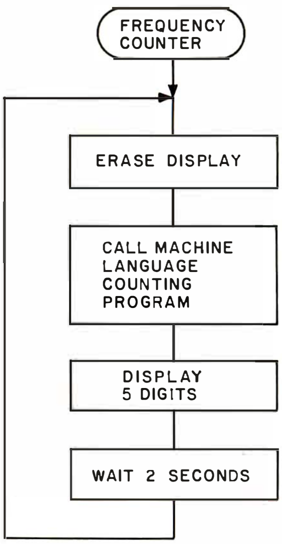


Figure 1: *General flowchart for a program that enables a microcomputer to act as a frequency counter.*

The program derives its accuracy from the crystal clock that runs the microprocessor. Timed program loops check the input line at precise intervals to obtain a count. Figure 1 shows the flowchart of the program. The program is shown in listing 1. It consists of a COSMAC VIP CHIP-8 interpretive-code main program for control and display, and an RCA CDP1802 machine-language subroutine to perform the counting function.

One of the parameters passed to the machine-language subroutine is a time parameter that, when incremented to zero, gives a precise 1-second interval used in counting. The COSMAC VIP has a 3.521280 MHz crystal. If you use a different crystal, the following formula will provide a number that, when subtracted from 65,536, will count for one second:

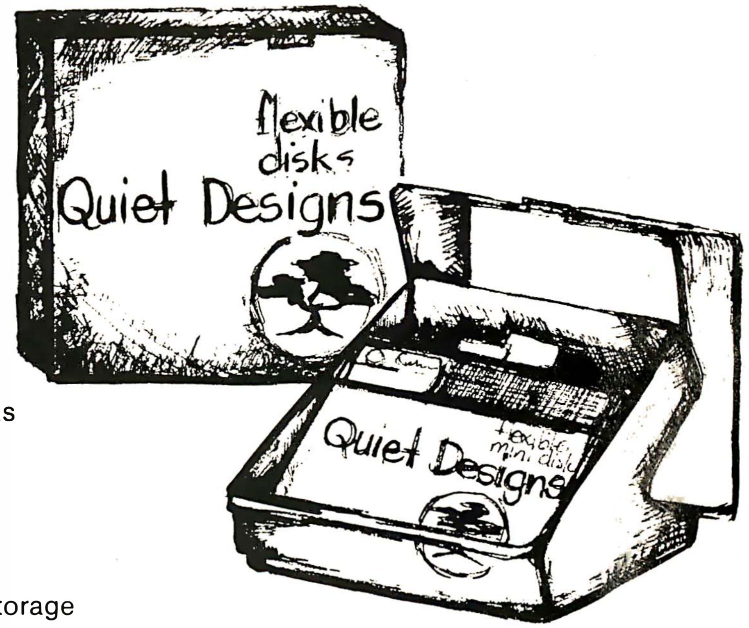
$$T = \frac{\text{number of clock cycles in 1 second}}{\text{number of clock cycles to execute looping instructions}}$$

$$= \frac{\frac{F}{2} \times \frac{10^6 \text{ clock cycles}}{\text{second}} \times (1 \text{ second})}{\frac{8 \text{ clock cycles}}{\text{machine cycle}} \times \frac{2 \text{ machine cycles}}{\text{instruction}} \times (5 \text{ instructions})}$$

$$= \frac{F \times 10^6}{160}$$

Circle 240 on inquiry card.

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ADDRESS	CODE	COMMENTS
0200	00E0	ERASE DISPLAY
0202	A3FB	I=ADDR OF 5-BYTE DECIMAL-CONVERSION AREA
0204	0300	CALL MACHINE-LANGUAGE COUNTING PROGRAM
0206	AA08	TIME PARAMETER
0208	6600	V6=00
020A	6410	V4=10
020C	6510	V5=10
020E	A3FB	I=ADDR OF 5-BYTE DECIMAL-CONVERSION AREA
0210	F61E	I=I+V6 SET I TO DIGIT ADDRESS
0212	F065	V0:V0=MI V0 CONTAINS DECIMAL DIGIT
0214	F029	I=V0(LSDP) GET DIGIT PATTERN ADDR
0216	D455	DISPLAY DIGIT USING V4 AND V5
0218	7405	V4+05 NEXT HORZ TV DIGIT LOCATION
021A	7601	V6+01 NEXT DIGIT
021C	3605	SKIP IF V6=5
021E	120E	GO TO 20E
0220	6878	V8=78
0222	F815	SET TIMER FROM V8
0224	F807	GET TIMER INTO V8
0226	3800	SKIP IF V8=00
0228	1224	GO TO 224
022A	1200	GO TO 200

Listing 1: *The main frequency-counter program for the RCA COSMAC VIP microcomputer. The program is written in CHIP-8 interpretive code.*

where F is the crystal frequency in MHz. For F = 3.521280, T has the value 22,008. Since the program counts up to zero, the count used in the program is decimal 65,536 − 22,008 = 43,528, or hexadecimal AA08. Note that the VIP microcomputer halves F by using a flip-flop. The maximum frequency that can be counted by the program is $T/2$ or 11,004 Hz using the above crystal frequency. This assumes no half-cycle of the signal being measured is shorter than five instruction executions, or 45.438 μs.

The counting subroutine uses a five-instruction loop for counting in both the high and low halves of a cycle. Every five instructions, the time-parameter count is incremented by 1. When the time parameter becomes zero

Text continued on page 323

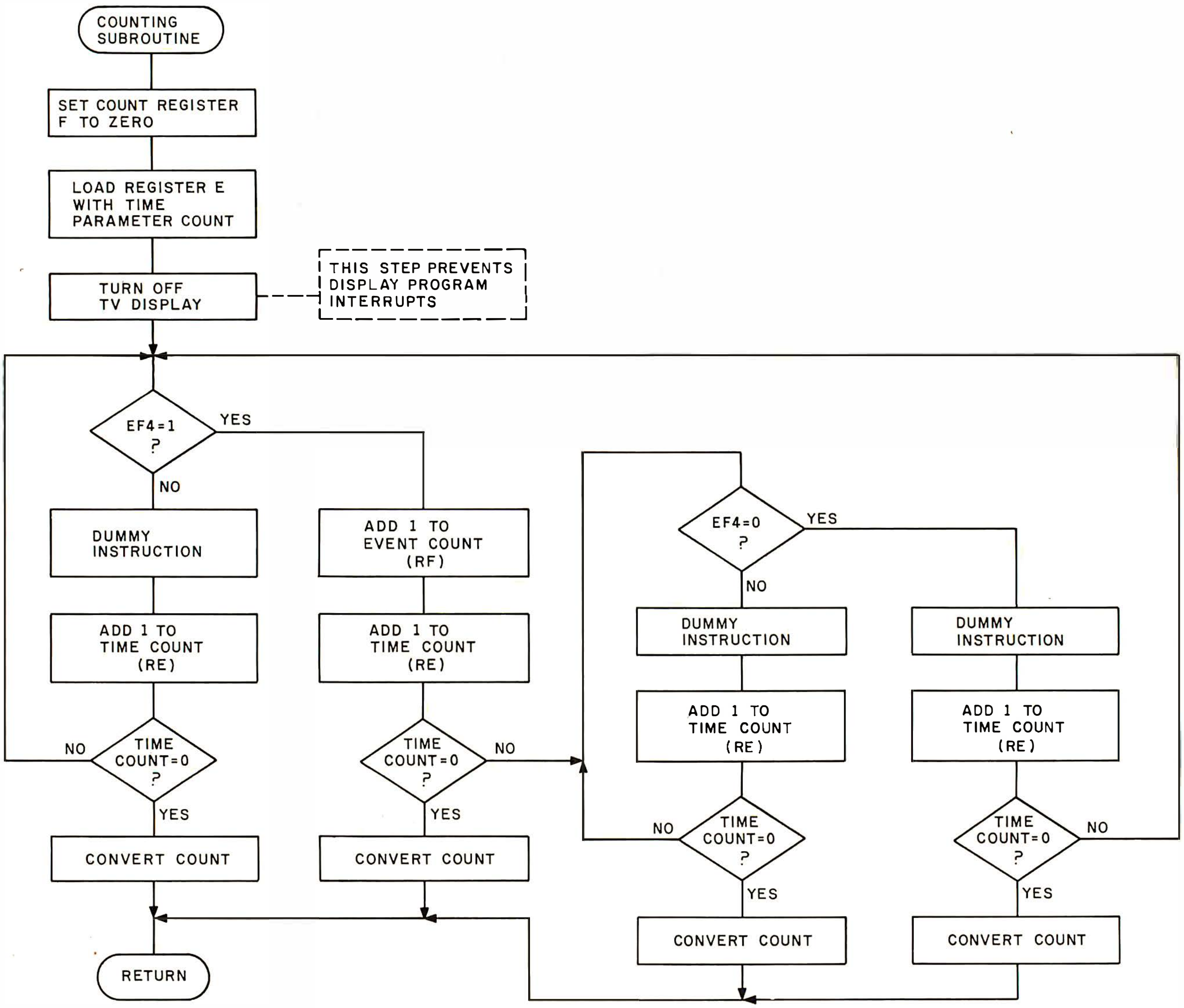


Figure 2: *Flowchart for the frequency-counting program written for the CDP1802 microprocessor. The program can be adapted to work with almost any microprocessor.*

Listing 2: *The counting subroutine for the frequency-counter program written for the RCA COSMAC VIP microcomputer. The subroutine is written in CDP1802 microprocessor code and corresponds to the flowcharts in figures 2 and 3.*

Hexadecimal Address	Hexadecimal Code	Label	Instruction Mnemonic	Operand	Comment
		*COUNTING PROGRAM			
		*REGISTER A CONTAINS ADDRESS OF FIVE-BYTE AREA			
		*SET EVENT COUNTER TO ZERO (REGISTER F)			
0300	F800	F COUNT	LDI	0	
0302	BF		PHI	F	
0303	AF		PLO	F	
		*SET TIME COUNTER (REGISTER E) TO PARAMETER			
		*TIME COUNTER VALUE FOLLOWS SUBROUTINE CALL			
0304	45		LDA	5	
0305	BE		PHI	E	
0306	45		LDA	5	
0307	AE		PLO	E	
0308	E2		SEX	2	
0309	61		OUT	1	TURN OFF TV DISPLAY
030A	22		DEC	2	
		*START COUNTING			
030B	3714	MAIN	B4	ON	BRANCH IF EF = 1
030D	9E		GHI	E	DUMMY INST
030E	1E		INC	E	
030F	9E		GHI	E	
0310	3A0B		BNZ	MAIN	
0312	3029		B	CONVD	
		*EF FLAG 1			
0314	1F	ON	INC	F	ADD 1 TO EVENT COUNTER
0315	1E		INC	E	
0316	9E		GHI	E	
0317	3A1B		BNZ	WZERO	
0319	3029		B	CONVD	
		*WAIT FOR EF 0			
031B	3F24	WZERO	BN4	OFF	BRANCH IF EF = 0
031D	9E		GHI	E	DUMMY INST
031E	1E		INC	E	
031F	9E		GHI	E	
0320	3A1B		BNZ	WZERO	
0322	3029		B	CONVD	
		*EF FLAG 0			
0324	9E	OFF	GHI	E	DUMMY INST

Listing 2 continued on page 322

Listing 2 continued:

```
0325    1E              INC    E
0326    9E              GHI    E
0327    3A0B            BNZ    MAIN
                *CONVERT BINARY TO DECIMAL (VALUE IN REGISTER F)
                *FIVE-BYTE AREA FOR STORING DECIMAL NUMBER IN REGISTER A
0329    F805    CONVD   LDI    5        NO. OF BYTES
032B    A7              PLO    7
032C    F803            LDI    03       SET REGISTER C TO CONVERSION TABLE
032E    BC              PHI    C
032F    F88F            LDI    8F
0331    AC              PLO    C
0332    9F              GHI    F        STORE RF (FOR DEBUGGING PURPOSES)
0333    5C              STR    C
0334    1C              INC    C
0335    8F              GLO    F
0336    5C              STR    C
0337    1C              INC    C
0338    EC              SEX    C        SET X TO C
0339    F8 00   ZCNT    LDI    0        SET COUNTER TO ZERO
033B    AD              PLO    D
033C    9F              GHI    F        MOVE RF VALUE TO RE
033D    BE              PHI    E
033E    8F              GLO    F
033F    AE              PLO    E
0340    8E      SUBREG  GLO    E        SUBTRACT TABLE ENTRY FROM RE
0341    F7              SM              SUBTRACT MEMORY
0342    AE              PLO    E
0343    1C              INC    C        NEXT TABLE BYTE
0344    9E              GHI    E
0345    77              SMB             SUBTRACT BORROW
0346    BE              PHI    E
0347    2C              DEC    C        ORIGINAL TABLE BYTE
0348    3B 51           BNF    BORROW
034A    1D              INC    D        ADD 1 TO COUNTER
034B    9E              GHI    E        MOVE RE TO RF
034C    BF              PHI    F
034D    8E              GLO    E
034E    AF              PLO    F
034F    30 40           B      SUBREG
0351    8D      BORROW  GLO    D
0352    5A              STR    A        STORE DECIMAL DIGIT
0353    1A              INC    A        NEXT DIGIT LOCATION
0354    1C              INC    C        NEXT TABLE ENTRY
0355    1C              INC    C
0356    27              DEC    7        SUBTRACT 1 FROM NUMBER OF BYTES
0357    87              GLO    7
0358    3A 39           BNZ    ZCNT
035A    E2              SEX    2
035B    69              INP    1        TURN ON TV
035C    D4              SEP    4        RETURN
0391            TABLE   # 1027          10000
                        # E803          1000
                        # 6400          100
                        # 0A00          10
                        # 0100          1
```


Circle 242 on inquiry card.

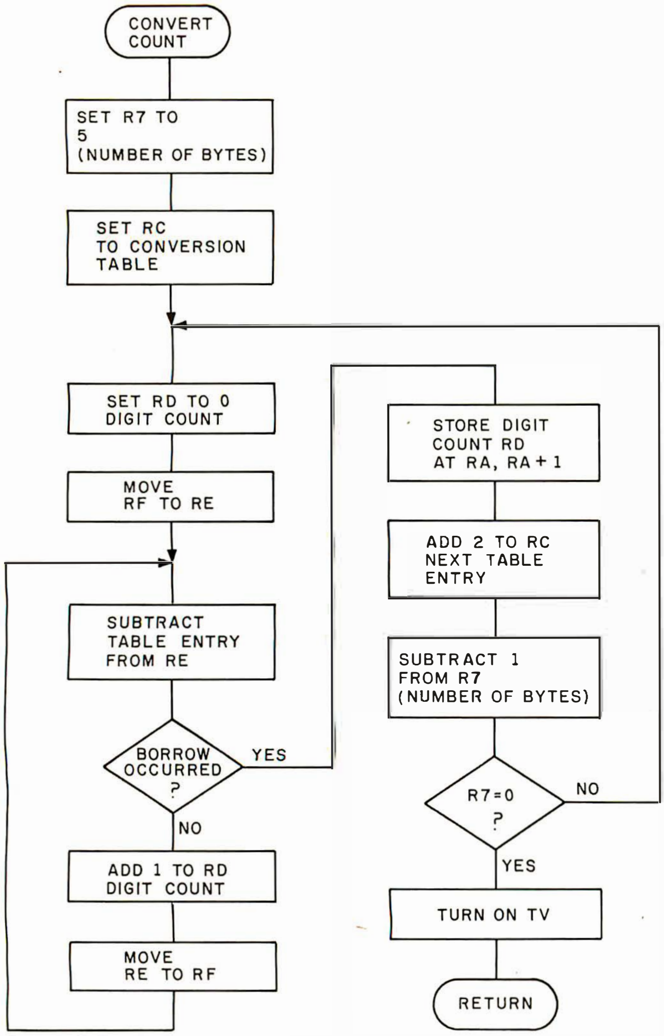


Figure 3: *Flowchart for the binary-to-decimal-conversion program. RA contains the address of the digit storage area.*

Text continued from page 320:
(this 16-bit value will overflow to zero at 65,536), the binary-to-decimal-conversion portion of the subroutine gets control. This routine successively subtracts multiples of ten stored in a table from the binary number and stores decimal digits each time the frequency count underflows.

Once you have your frequency counter running, you might want to modify the program to check EF2 instead of EF4 input. With this change, sine waves on EF2 can be counted using the tape-input line of the VIP.

Other useful applications for the frequency-counter program are the alignment of a modem kit like the Pennywhistle 103 and the adjustment of cassette-tape clock interfaces.

Even if you don't have a COSMAC VIP, you can program your microcomputer to perform frequency counts using the flowchart contained in this article. Happy counting! ■



SPEECH SYNTHESIS
BY TOM SLOAN
IT'S REALLY NEAT HOW THIS COMPUTER CAN GENERATE SPEECH.
MAKE LOGIC NOT WAR
VOICE 1 VOICE 2 VOICE 3 VOICE 4
WHAT'S GOING ON?
CPU
WELL, HE'S WRITING A 4 VOICE SPEECH SYNTHESIS PROGRAM.
WE'LL NEED 4 DIFFERENT PEOPLE FOR THE VOICES
I KNOW JUST WHO TO GET.
WALK THIS WAY GENTLEMEN
OK
HELLO
HELLO
HELLO
HELLO
NOW WHEN THE LED FLASHES, ITS YOUR QUE.
YA-YUP
OK MEN... WE'RE READY FOR A TEST.
ICE CREAM
ICE CREAM
ICE CREAM
ICE CREAGHH
COF CHOKE!
CRIPE! WHAT HAPPENED TO THE 4TH VOICE!?
RUN
ERROR
I ♡ WARS
COF GAG COF
OH NO! YOU GOT LARYNGITIS!
MAYBE IT'S A BAD I.C.
VOID
IT COULD BE THIS BIG ONE.
TTL LIVES
PLIP
AHH
WHAT'S WRONG WITH YOU!
THIS SPACE FOR RENT
HOLD YOUR PANTS ON!
HOW'S THAT?
COF... AHEM... BETTER!
PSSST
I'LL PUT IT BACK AND TRY IT AGAIN.
EPROM TECH.
NOT AGAIN! EEEK
MAYBE IT'LL WORK NOW.
RUN
I.C.U.
ORANGE 2
WE'RE READY FOR THE REAL THING. THIS IS NOT A TEST.
TOM SLOAN
GEE ITS NICE WHEN YOUR COMPUTER RUNS PROPERLY
THAT GUY BETTER NOT SHAKE US UP AGAIN!
YOU SAID IT.

KNIGHT: A Knight's Tour Problem in MMSFORTH

Ulrich Frei, Aalweg 13, D 7922 Bolheim, West Germany (BRD)

I run MMSFORTH on my Radio Shack TRS-80 Model I. I wrote the KNIGHT program in listing 1 to compare the speed of FORTH with other languages. The program in listing 1 shows the trial-and-error solution of the Knight's Tour problem (ie: to find a sequence of Knight moves such that each chessboard square is visited exactly once) displayed on the screen while the solution is being worked out. A modified version of this program that does not give a dynamic display of each move was compared in execution speed and relative program size to the same algorithm coded in TRS-80 Level II BASIC and in Z80 machine code. The results are given in table 1. ■

Listing 1: *The program KNIGHT, a Knight's Tour problem written in MMSFORTH. This listing was made on a European printer, which necessitates the American user to change all the percent signs (%) to exclamation points (!). The exclamation point is actually the familiar "store-value" variable in FORTH and is used in the words* { ! } *and* { +! }.

```
( KNIGHTSTOUR                                PART 1 OF 4     BLOCK 80 )
( TO START, TYPE    80 LOAD     <ENTER>                               )
( REPLACE % WITH EXCLAMATION-MARK                                     )

: TASK ;                       28 LOAD      ( LOAD ARRAY-ROUTINE )

11  11  2ARRAY  BOARD                       ( BOARD-REPRESENTATION )
64 ARRAY DIRECT                             ( STORAGE OF DIRECTION )
7 ARRAY DX     7 ARRAY DY                   ( POSSIBLE DISPLACEMENTS )

2 VARIABLE XNEW   2 VARIABLE YNEW           ( FUTURE  POSITION )
2 VARIABLE XPOS   2 VARIABLE YPOS           ( CURRENT POSITION )
1 VARIABLE N                                ( NUMBER OF MOVE )


81 LOAD



( KNIGHTSTOUR                           PART 2 OF 4      BLOCK 81 )

: INIT    CLS
          12 0 DO 12 0 DO -1 I J BOARD % LOOP LOOP
          10 2 DO 10 2 DO  0 I J BOARD % LOOP LOOP
          1 2 2 BOARD %
          65 0 DO 0 I DIRECT % LOOP
          8 0 DO 8 0 DO I 2 * J 8 * PTC "   - " LOOP LOOP
          0 0 PTC " 1 "
           2 0 DX %    1 1 DX %   -1 2 DX %   -2 3 DX %   -2 4 DX %
          -1 5 DX %    1 6 DX %    2 7 DX %
           1 0 DY %    2 1 DY %    2 2 DY %    1 3 DY %  -1 4 DY %
          -2 5 DY %   -2 6 DY %   -1 7 DY %
           2 XPOS % 2 YPOS % 2 XNEW % 2 YNEW % 1 N %
;
82 LOAD



( KNIGHTSTOUR                               PART 3 OF 4      BLOCK 82 )

: POSCHK XPOS @ N @ DIRECT @ DX @ + XNEW %
         YPOS @ N @ DIRECT @ DY @ + YNEW %
         XNEW @  YNEW @  BOARD @    0=                                 ;

: MOVE   XNEW @ XPOS %   YNEW @ YPOS %    1 N +%
         YPOS @ 2 - 2 * XPOS @ 2 - 8 * PTC N ?  ( DISPL. MOVE )
         N @ XPOS @ YPOS @ BOARD %    ( UPDATE BOARD )                 ;

: BACK   YPOS @ 2 - 2 * XPOS @ 2 - 8 * PTC "   - "
         0 N @ DIRECT %    0 XPOS @ YPOS @ BOARD %    N @ 1 - N %
         XPOS @ N @ DIRECT @ DX @ - XPOS %
         YPOS @ N @ DIRECT @ DY @ - YPOS %                             ;

83 LOAD



( KNIGHTSTOUR                                   PART 4 OF 4    BLOCK 83  )
: KNIGHT            CLS  INIT
                    BEGIN  POSCHK
                           IF  MOVE
                           ELSE  N @ DIRECT @ 7 =
                                 IF BACK
                                    BEGIN BACK
                                    N @ DIRECT @ 7 <
                                    END
                                 THEN
                           1 N @ DIRECT +%
                           THEN
                    N @ 64 =
                    END                   KEY DROP   ( STOP )
;
KNIGHT
```

Language	Execution Time	Relative Size of Program
Z80 machine language	1 min, 06 sec	1
MMSFORTH	30 min	27
Level II BASIC	9 hr, 52 min	539

Table 1: *Comparative execution times and program sizes of three versions of the same program. The same algorithm was used to code each of the three versions of the Knight's Tour problem, one version each in Z80 machine language, MMSFORTH, and Level II BASIC. The machine used was a Radio Shack TRS-80 Model I.*

A Heating and Cooling Management System

Tom Hall
8500 Cameron Rd
Austin TX 78753

This article describes a practical application for computer-automated management of your home's heating and cooling needs.

Let's review some simple facts about the home that will be helpful in planning a home heating and cooling management system. Of course, you may have a few of your own to add after reading the list:

- The kitchen is usually warmer than the rest of the house during cooking periods.
- The laundry room, while being used, is usually warmer than the rest of the house.
- During normal sleep periods, we care only about the temperature of the bedrooms.
- In a two-story house, the temperature upstairs is usually significantly warmer than downstairs.
- We do not care what the temperature is (within reasonable limits) in the house when we are away.

Now let's take a look at the basic weakness of most central heating (and air conditioning) units. There is only one thermostat and it is located in one room. Therefore, only the temperature of that room is really regulated, and the thermostat must be manually adjusted. Now let's examine a system that can be used to help manage the heating and cooling of a home. The components of the system are the computer, the central heating unit, a real-time clock, a switch that indicates whether anyone is at home, and an array of computer-compatible temperature sensors.

Your personal computer can optimize your home heating and cooling system even when you're away from home.

Designing the System

The first step is to determine how many of the temperature sensors you will need. For a week or so, measure the temperature in each room of your house about six or eight times a day. At least two of these times should be during cooking and washing periods. You will probably find that the temperatures in all the bedrooms are about equal. Several other rooms will probably be similar under most conditions. The number of sensors needed for your home will vary with your conditions, but you will probably not need a sensor in every room. You will want to place a temperature sensor outside, in the kitchen, in a bedroom, and in any room that shows a temperature difference of several degrees in a day's time.

To approximate the thermal capacity of each area, determine the number of cubic feet of space served by each sensor. This is necessary to compute the average temperature of the house. From this information, we will decide whether to turn on the heating (or cooling) system or to just balance the temperature throughout the house by turning on blower fans. Of course, when we do not care about the temperature balance (such as when we are sleeping or away from home), it will not be controlled as tightly.

The flowchart of figure 1 presents a possible control routine for the hardware described here. It is written for winter with the assumption that our main concern is keeping the house warm.

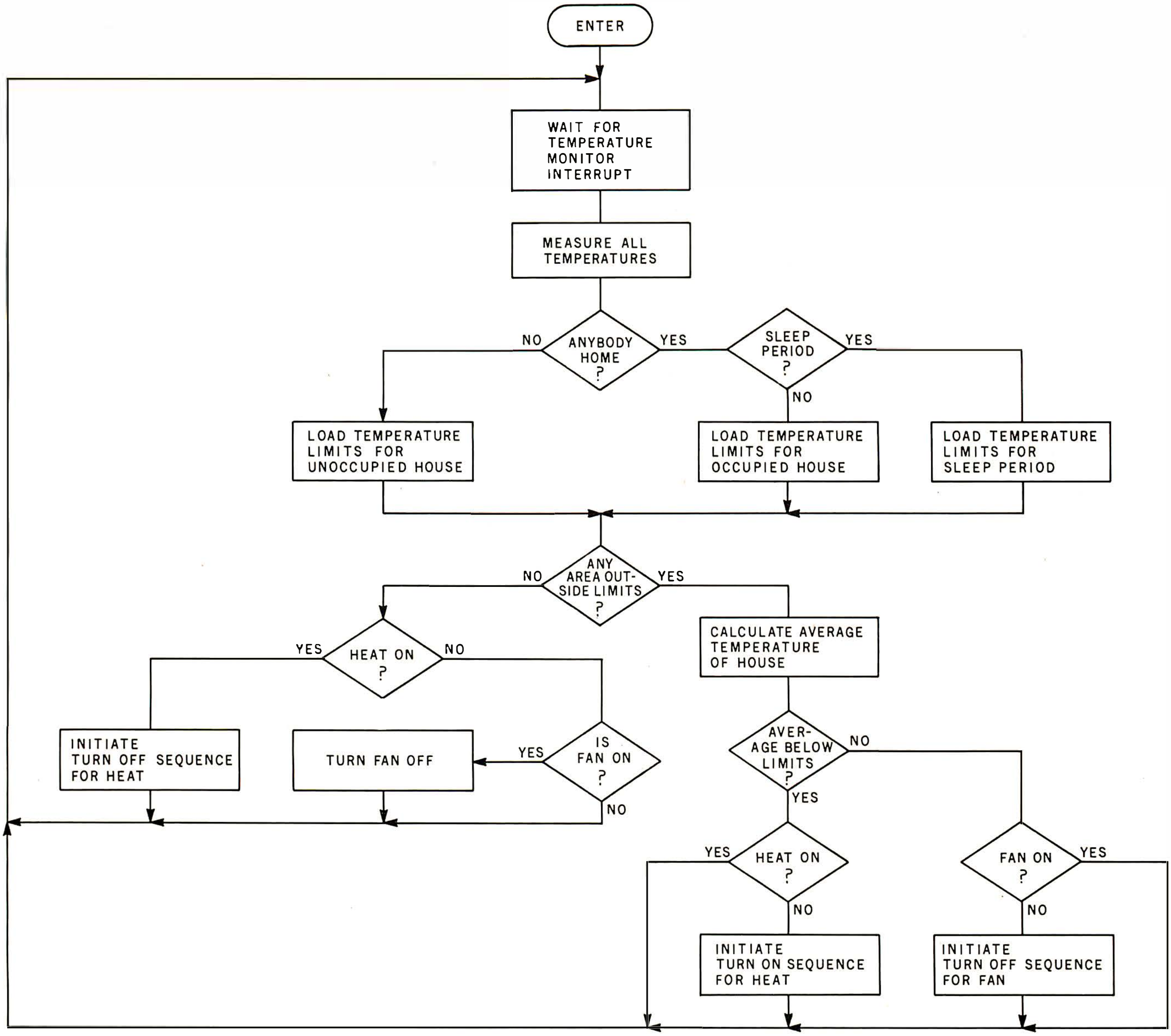


Figure 1: *Flowchart for a winter temperature-control program. Use of this flowchart assumes that the computer has control of the house thermostat and fans and that it can sense temperature through several remote temperature transducers, the sleep/waking status through a real-time clock, and the home/gone status through a user-controlled remote switch.*

The flowchart is self-explanatory, but several notes are in order. When installing an interface to your heating system, be sure to leave the existing thermostat active for safety reasons. Also, if you are not familiar with the workings of your heating unit, ask for assistance from a professional.

Hardware Description

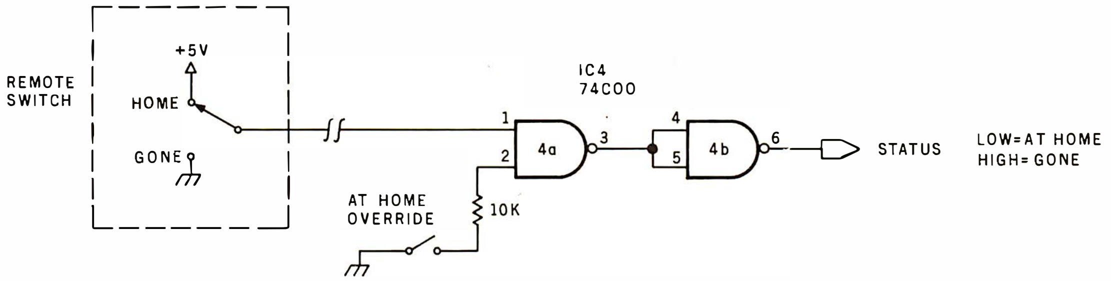
Figure 2 demonstrates two versions of the remote switch that tells the computer whether or not anyone is home. The version in figure 2a uses one wire from the computer connecting through the remote switch to a natural ground (for example, a water pipe). The software that samples the STATUS bit should do so several times in order to be sure of the remote switch's position.

Because the use of the home's ground may produce a false reading (due to the "noise" of household appliances, among other things), the more complex circuit of figure 2b provides a foolproof solution; its disadvantage is that it requires three extra remote lines. The 1 k-ohm resistor close to the 5 V supply limits the current coming from the source in case of an accidental short. The IC4a and IC4b pair form an RS latch that holds the most recent value of the remote switch (which is a momentary closure switch). This circuit has the advantage of requiring only a conventional electrical ground. The AT HOME OVERRIDE switch is located close to the computer so that the user can change the value of STATUS without throwing the switch at the remote location.

Figure 3 is a schematic of the temperature sensor, which is based on a National Semiconductor LX5700 temperature transducer. The circuit converts the analog output of the transducer to a pulse frequency via a timer circuit. We can later convert this in

Text continued on page 330

(2a)



Number	Type	+5 V	GND
IC3	7404	14	7
IC4	7400	14	7

(2b)

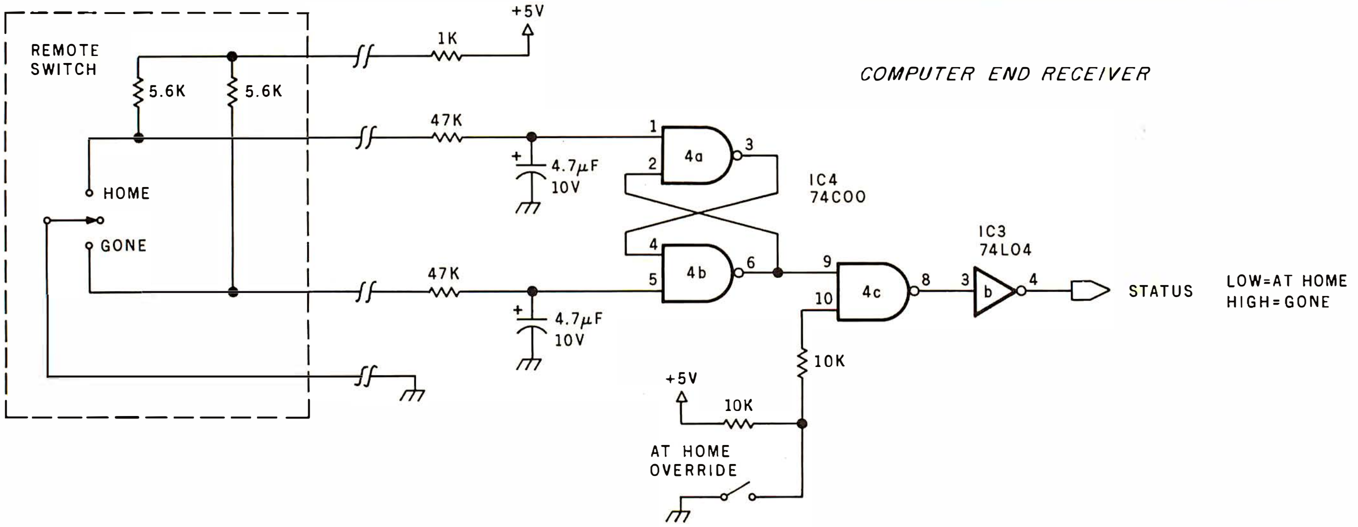
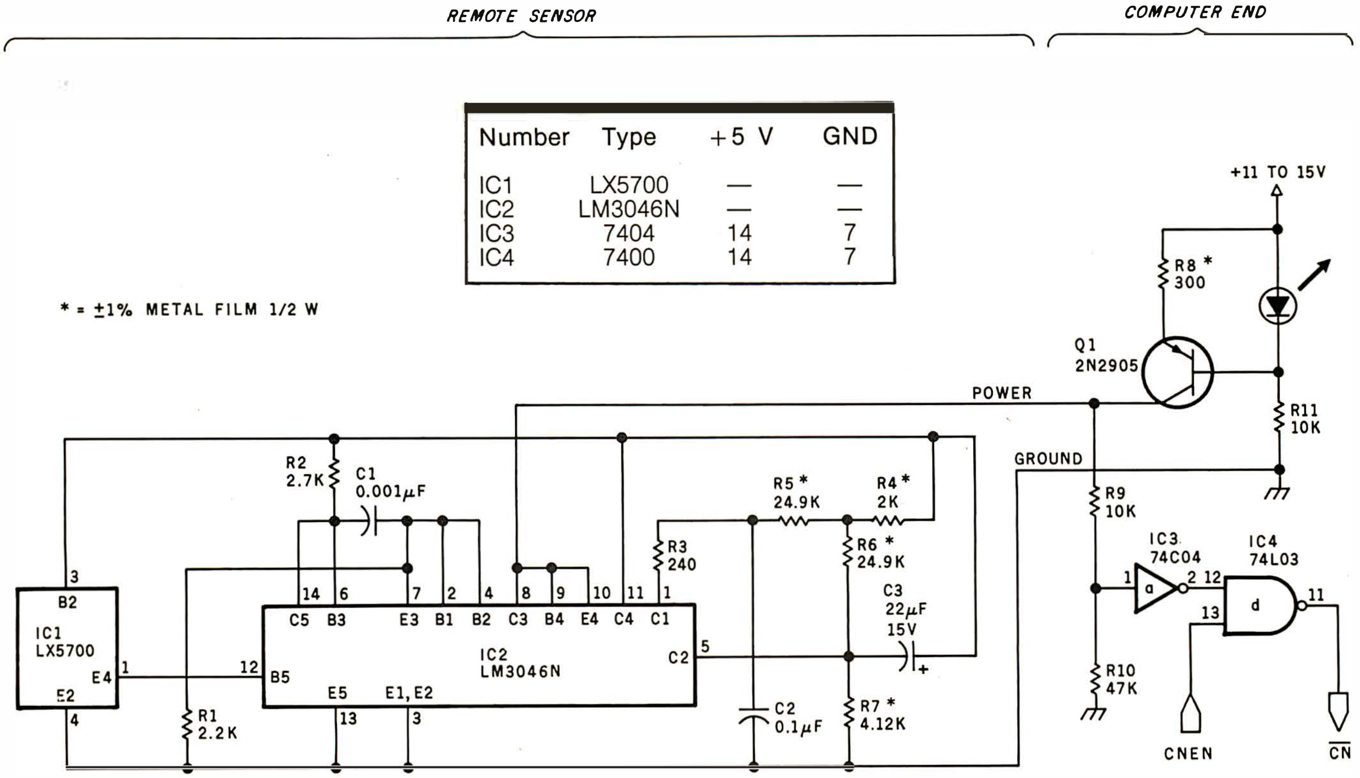


Figure 2: *Schematic diagram for the home/gone remote switch. The version of this switch given in figure 2a is simpler, using fewer components and wires, but it may be vulnerable to electrical "noise" in the natural (house) ground it makes use of. The version in figure 2b is more complex, but it uses a conventional (equipment) ground and two NAND gates wired as a set-reset (RS) latch that remembers the most recent switch position.*



Number	Type	+5 V	GND
IC1	LX5700	—	—
IC2	LM3046N	—	—
IC3	7404	14	7
IC4	7400	14	7

Figure 3: *Schematic diagram for the remote temperature sensor. IC1 is the temperature sensor, while IC2 is a transistor array that exhibits stability over a wide temperature range. The output bit CNEN must be high to allow the pulse train* $\overline{CN}$ *to appear. The frequency of the pulse train at* $\overline{CN}$ *is proportional to the temperature being sensed.*

Number	Type	+5 V	GND
IC5	74198N	24	12
IC6	DM8556N	16	8
IC7	DM8556N	16	8
IC8	DM8556N	16	8
IC9	DM8556N	16	8
IC10	7404	14	7

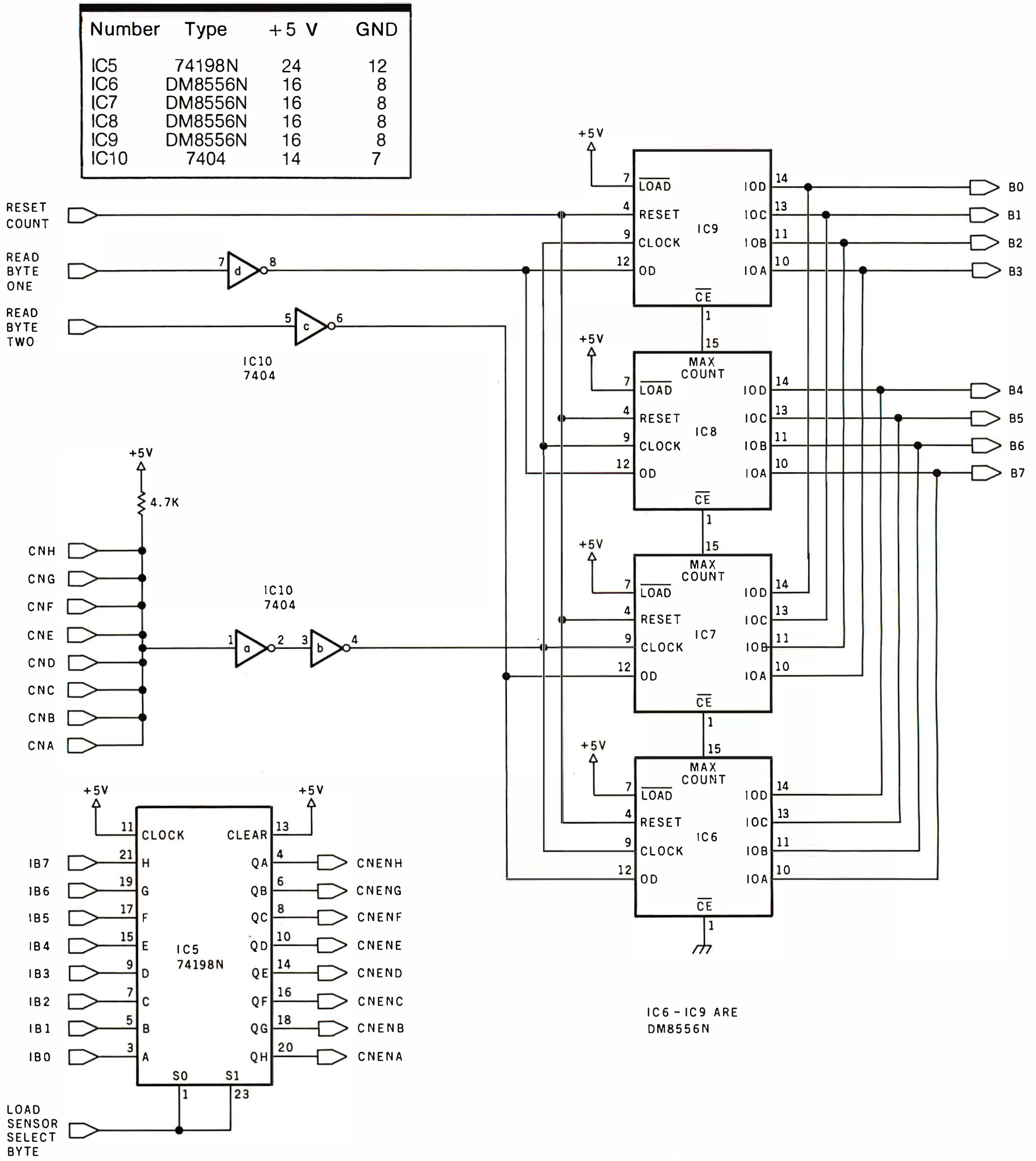


Figure 4: *Schematic diagram for a temperature-count accumulator. This circuit allows the computer to count the pulses from any one of the eight temperature sensors. After the count is finished, the circuit returns the count as an absolute 16-bit number delivered 1 byte at a time. IC5 is an 8-bit shift register that transfers the 8 bits coming from the computer (IB0 thru IB7) to the enable lines of the eight temperature sensors (CNENA thru CNENH) when the load-sensor-select-byte input line goes high. IC6 thru IC9 are three-state binary counters that are cascaded to form a 16-bit counter.*

Text continued from page 327:
software to a temperature reading.

In figure 3, the circuit formed by the transistor Q1, the light-emitting diode (LED), and their two associated resistors forms a *constant-current source.* A constant-current source is an efficient way of sending power to a remote circuit because the impedance of the power line to the remote circuit is not critical. Also, a zener diode is present within IC1 to regulate its voltage.

To minimize the number of wires running to the multiple remote sen-

$$\left(\begin{array}{l}\text{Count Change}\\ \text{Per } 1^\circ \text{ F}\\ \text{Temperature}\\ \text{Change}\end{array}\right) = \frac{(\text{Counts at Hot Water Temperature}) - (\text{Counts at } 32^\circ \text{ F})}{(\text{Corrected Hot Water Temperature})}$$

To figure the actual temperature:

$$\left(\begin{array}{l}\text{Temperature}\\ \text{in Degrees}\end{array}\right) = \frac{(\text{Number of Counts for Unknown Temperature}) - (\text{Counts at } 32^\circ\text{F})}{(\text{Count Change per } 1^\circ \text{ F of Temperature Change})}$$

Table 1: *Equations for obtaining corrected temperature readings from the sensors.*

sors that this design requires, I used a technique that allows the use of the same wire both to supply power to the integrated circuits and to return the pulse train from IC2. The pulse train from IC2 pulls the power line low enough to be recognized as a logical low by IC3. During the short periods that the power line is low, the capacitor C3, assisted by the constant current coming from the transistor-LED pair even when the power line *is low*, maintains power to the sensor.

The pulse train arriving at IC3 has a frequency that is proportional to the temperature being sensed by IC1. The NAND gate of IC4 allows the CNEN line to control the flow of the pulse train to the $\overline{\text{CN}}$ line.

Figure 4 shows the temperature-count accumulator that receives the $\overline{\text{CN}}$ signal from any one of eight sensors. The circuits IC6 thru IC9 are each binary counters with three-state outputs (high, low, or disconnect). They will be used to count the number of pulses in a fixed time frame from each sensor in its turn. Figure 5 shows a timing diagram for the temperature accumulator and gives an explanation of its workings.

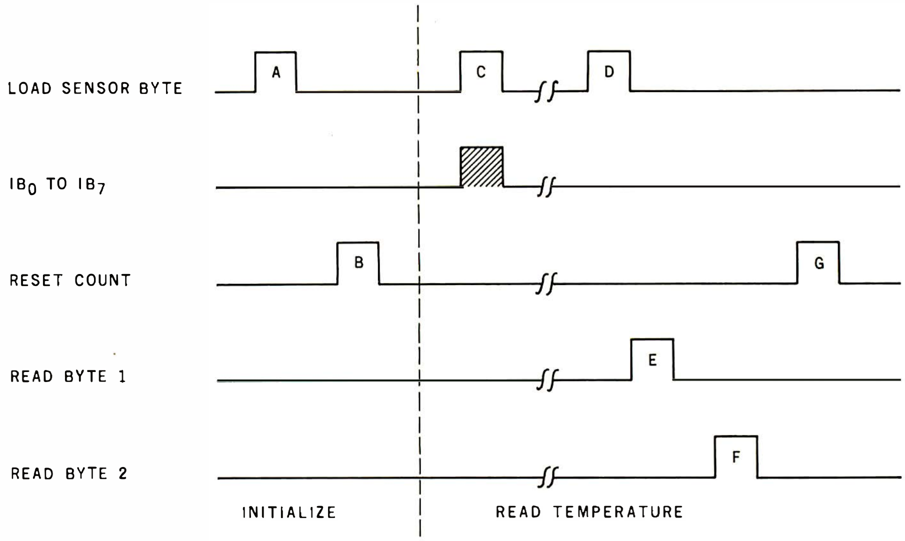


Figure 5: *Overview of the temperature-sensing process. The events must take place in the following sequence: (A) Deselect all sensors by setting IB0 thru IB7 to zeros, then raising the load-sensor-select-byte bit to high. (B) Reset the temperature count with a positive pulse. (C) Select the desired sensor by the above method, but with a 1 going to the IB line of the chosen sensor. (D) After the count is completed, deselect all sensors as in step A. (E) Get the low byte of the count by pulsing the read-byte-1 line. (F) Get the high byte of the count by pulsing the read-byte-2 line. (G) Reset the temperature count as above; then go back to C if more sensors are to be read.*

To calibrate the sensors, a large bucket of ice and a thermometer capable of measuring temperatures from about -5° F to 120° F are needed. The sensor to be calibrated should be hooked up to the computer in the same way that it will be for remote-temperature sensing. The real-time clock should allow the sensor to count for about 0.5 seconds before the computer reads its count value from the circuit in figure 4. The count for the sensor should be in the range of 3000 to 15,000 counts; this tells us only that the sensor is functioning.

Take each sensor and dunk it in the bucket of ice. Pour in just enough water to cover the ice, stir, and stick the thermometer in. This is called an ice-point bath. The count from each sensor is the number of pulses equivalent to a temperature of 32° F. Confirm this reading with your thermometer, which should also read 32° F. If it does not, note the difference in the two readings—this number can be used as a correction factor in the next step.

Take the sensors out of the bucket and pour out the ice water. Rinse the bucket with hot tap water. Then fill the bucket with hot tap water, put the sensors back in the bucket along with the thermometer, and stir again. Read the thermometer and record the count for each sensor at the new temperature. If the reading at 32° F was off, you will have to adjust the new temperature by the same amount. This gives us the corresponding count for each sensor for two temperature extremes. From this we can easily determine the temperature of a given sensor by using the equations in table 1. Knowing the temperature from each sensor, you can proceed to write a program from the flowchart and start keeping track of your home heating system. ■

1. Lefferts, Peter, *Linear Applications 2* (National Semiconductor, Santa Clara, California).
2. Smith, M F, "Using Interrupts for Read-Time Clocks," BYTE, November 1977, pages 50 thru 53.

Modifying the SwTPC Computer

Thomas J Weaver
825 N Sherry Ave
Norman OK 73069

Changing to a newer 6809 microprocessor is a simple way to upgrade a 6800-based computer. In fact, Southwest Technical Products Corporation makes a conversion kit for its 6800 system that includes a 6809 processor board (see photo 1) and complete instructions. The kit can be built in one evening, but does require some modifications to the existing system.

Because of changes that I had already made to my computer, I was able to ignore the modifications suggested for the memory boards and disk controller. However, these changes are not complex, and should not require much time.

What I found most upsetting were the modifications that had to be made to the motherboard. These changes, if made, would not allow the use of the 6800 processor board. Because I have many large 6800 programs in binary form, without source code, it became necessary for me to fix the motherboard so that it would work with either processor board.

Although several of the bus lines are redefined for 6809 use, some of the changes do not affect 6800 operation. For example, the 6809 uses the UD2 line for the active-low FIRQ signal. All told, these are only five incompatible signals.

By installing a five-pole, two-position switch, it is a simple matter to change the configuration from 6800 to 6809. Most of the wiring attachments to the motherboard can be made in a small area, and a ribbon cable allows the switch to be mounted above the reset and power controls. Other connections must be made to the reset switch and the motherboard power-supply connector. These connection points on the bottom of the MP-B motherboard are shown in photo 2. Table 1 summarizes the jumpers and traces that must be cut. See figure 1 for the various switch connections.

When the modifications are complete, either processor board may be used by connecting or disconnecting the 6809 reset cable, changing pro-

Connection Points

A UD3 on I/O bus
B SELECT 5 on I/O bus
C IC 6 pin 7
D IC 6 pin 11
E IC 6 pin 6 (at R12)
F A12 line on SS50 bus
G IC 5 pins 5, 6
H IC 4 pin 2 (on connector line)
I IC 4 pins 9, 10
J IC 4 pin 11
K IC 4 pin 12
L IC 3 pin 6 (at R11)
M Master Reset line on SS50 bus
N UD2 line on SS50 bus
O +5 V (at R1, R2, R3, et al)
P reset switch
Q reset switch
R power supply connector pin 9

jumper:
A — B
H — L
N—ʌʌʌ—0
6.8 k-ohm
P — 6809 reset connector
Q — 6809 reset connctor

cut:
D —/ /— G
near D
I —/ /— K
remove master reset line at motherboard

Table 1: *The five-pole, two-position switch of figure 1 is connected to the points specified in this table. Note that not all modifications are made directly to the switch; some are jumpers.*

Address Translation of 48 K Bytes

Physical Address	Logical Address
0xxx	0xxx
1xxx	1xxx
2xxx	2xxx
3xxx	3xxx
4xxx	4xxx
5xxx	5xxx
6xxx	6xxx
7xxx	7xxx
Axxx	8xxx
Bxxx	9xxx
Cxxx	Cxxx
Dxxx	Dxxx

Table 2: *Physical and logical memory addresses are mapped in a slightly different manner.*

cessor boards, and resetting the five-pole switch. Eventually, I plan to disassemble my binary programs and reassemble them on the 6809; but this system is quite flexible, so there is no rush. This allows me to evaluate and disassemble newly acquired 6800 programs without having to borrow a friend's 6800 system.

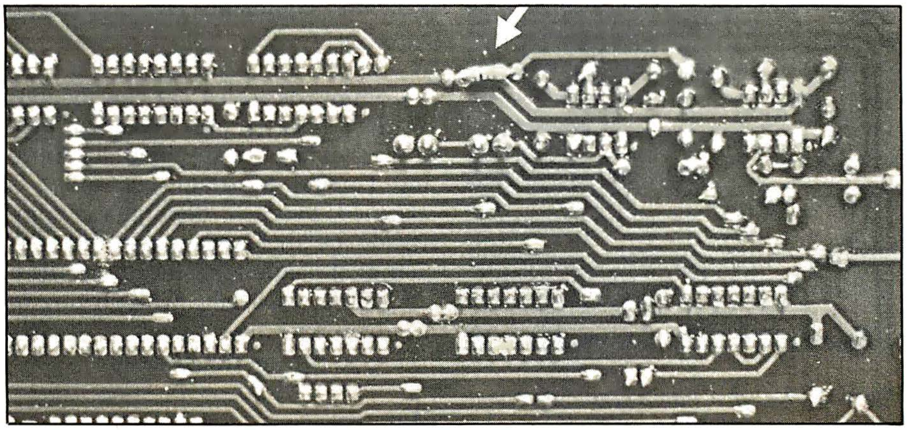


Photo 1: *To ensure proper operation of the 6809 processor board, in a modified system, resistor R20 should be installed on the solder side of the board, as shown. It is necessary to trim the leads flush with the top of the board, since they will be covered by the NMI/RESET connector.*

The Monitor

The 6809 processor board includes space for four 2716-compatible 2 K-byte programmable-memory integrated circuits. The address locations for the first two circuits overlap I/O port addresses, while the third has addresses identical to the 8-inch floppy-disk controller board (this presents no problem for those using 5-inch floppy disks). The last of the four sets of addresses is occupied by the SBUG-E monitor read-only-memory integrated circuit.

This monitor is slightly different from SwTPC's SWTBUG monitor, for the 6800 processor, but is also similar in many ways. This monitor allows all registers to be examined and set directly, using the Control key, in combination with the register name. For example, keying Control-D allows the user to examine or change the direct-page register. In the SBUG-E monitor:

- all registers may be *displayed* using the R command, and the system stack may be *examined* using the S command.
- There are separate commands to *boot* 8-inch (D) and 5-inch (U) floppy-disk units.

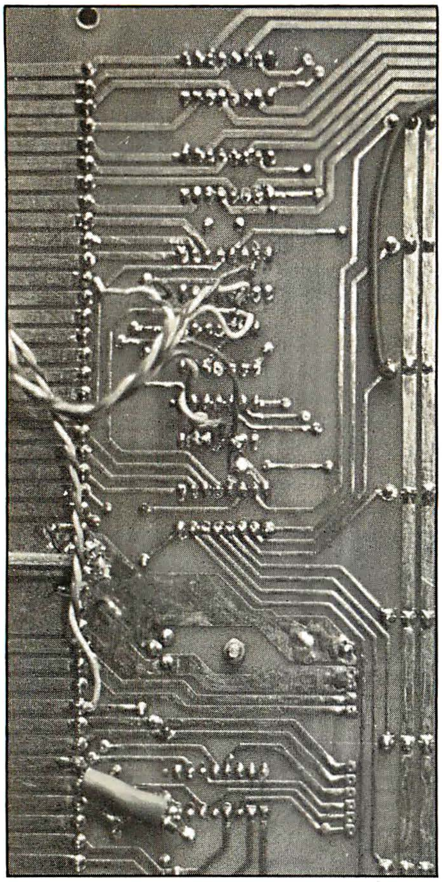


Photo 2: *Use of a ribbon cable allows a five-pole, two-position switch to be mounted in a convenient location on the front panel.*

- A *memory-dump* command (E) produces hexadecimal and ASCII dumps.
- The familiar *byte-examine and byte-change* command (M) is still implemented.
- A *memory-test* command (Q) checks a specified block of memory.
- The *go* (G) command has been restructured to obtain the program execution address from the program-control register, rather than hexadecimal location A048.
- The *go* command also removes software interrupts created by the *set breakpoint* (B) command.
- All breakpoints may be removed at once using the X command.
- The MIKBUG *tape load* (L) and *punch* (P) commands are still present.

Commands which are conspicuous by their absence are J (execute program starting at specified location) and F (find locations containing a specified byte). I hope these commands are included in the next version of the monitor, since I use them frequently, especially while trying to discover why new binary programs refuse to run on my system.

Memory

One of the areas that must be mastered before using the memory check (Q) command is Dynamic Address Translation. Basically, memory may have different physical and logical addresses. When powered up, the monitor checks the amount of memory available, and then maps it in 4 K-byte segments, using the following hexadecimal hierarchy: Dxxx, Cxxx, 0xxx, 1xxx, 2xxx, 3xxx, 4xxx, 5xxx, 6xxx, 7xxx, 8xxx, 9xxx, Axxx, Bxxx. Up to 56 K bytes of programmable memory may be mapped in this manner. An example of the physical and logical addresses of 48 K bytes is shown in table 2. Since the modifications mentioned do not permit user memory at physical addresses 8000 thru 8FFF for 6800 operation, the memory limit for systems with this modification is 52 K bytes.

The address table for the software interrupts (SWI, SWI2, and SWI3) and the interrupt requests ($\overline{IRQ}$ and FIRQ) is near the top of the user memory beginning at hexadecimal address DFC0. This table also includes the lower and upper limits for a supervisor-call address table, used in connection with the SWI3 instruction. When an SWI3 instruction is encountered, the following byte is examined. Assume this next byte contains the value n. If the user has provided a supervisor-call address table containing at least $n+1$ addresses, the supervisor routine indicated by the $(n+1)$th address will be executed. If the supervisor-call address table is not present or does not contain enough entries, the regular SWI3 address will be used.

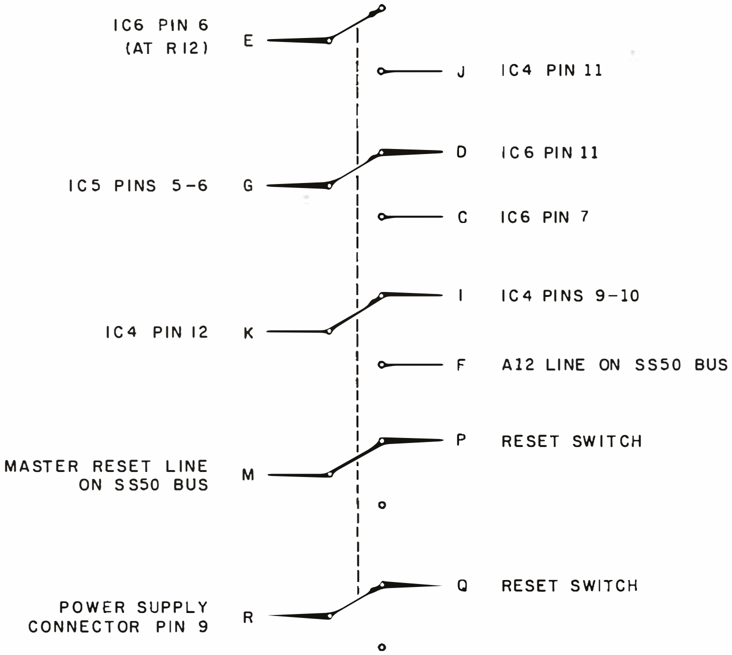


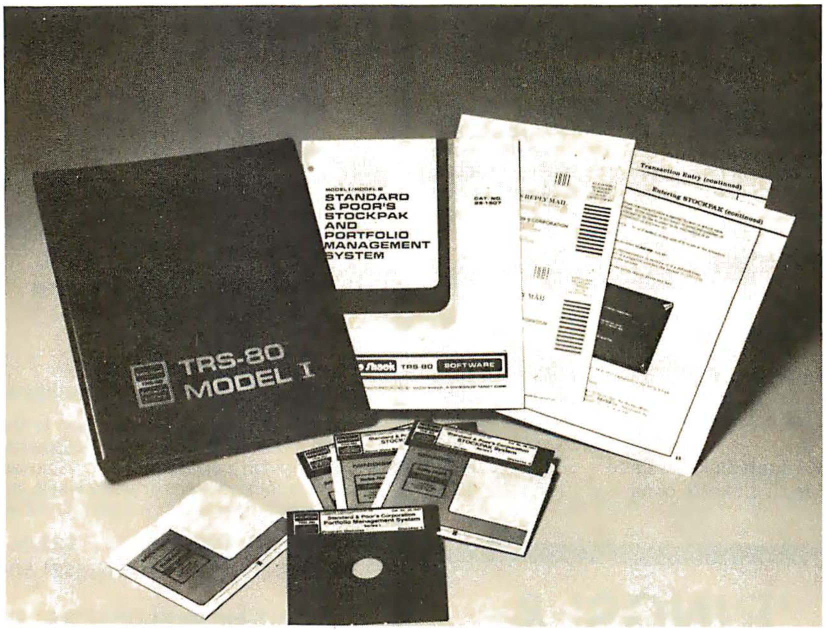
Figure 1: *The free end of the ribbon cable is connected to a five-pole, two-position switch, according to this diagram.*

Extras

Several parts of the MP-09 processor board have obviously been designed for expansion. Simple, on-board connectors reconfigure the data rate lines for speeds from 110 to 38,400 bps (bit per seconds), or use the 110 bps line as a *Bus Request* line. These and other features suggest that SwTPC has specific enhancements in mind.

The FLEX2 (6800) and FLEX9 (6809) 5-inch floppy-disk operating systems from TSC (Technical Systems Consultants) further enhance the use of this modification. Text files, BASIC programs, and source code may be easily transferred from one system to the other since both use the same disk format. Now disks as well as hardware can be used interchangeably with a dual 6800/6809 system. ■

Stock Portfolio Package



Stockpak combines Standard & Poor's expertise with the latest analytical methods of Wall Street investors to help users buy and sell stocks and to manage portfolios. Stockpak assists in evaluating and managing a portfolio of up to 100 securities, with as many as 30 transactions on each issue. Up to 900 New York and American Stock Exchange and over-the-counter common stocks can be analyzed. Users can record buy and sell transactions, price, dividend information, and stock splits. Companies can also be analyzed. Designed for TRS-80 users, the four Stockpak floppy disks contain the portfolio-management system, screen and select system, a report writer system, and a demonstration data base. Stockpak is a creation of the Standard & Poor's Corporation, and it is available for $49.95 at Radio Shack outlets. An annual subscription to a monthly update service is available for $200.

Circle 400 on inquiry card

APEX—Apple II Floppy-Disk Operating System

The APEX disk operating system features a command structure that is similar to CP/M's. Twenty command words are contained within the system, and APEX has the ability to treat external programs as transient commands to the operating system. There is a scrolling editor that is compatible with the Videx 80 character card. APEX can handle both 5- and 8-inch floppy and hard disks on the same system, and it is fully functional on single-drive and multidrive systems. Backup files, a backup directory, read-after-write, and size limit checks are included. File allocation techniques make APEX's file handling four times faster than CP/M's. Automatic default structures set up command strings, file names, and extensions. A special device handler structure allows for interfacing nonstandard peripherals. The basic APEX package includes a two-pass resident assembler and a macro-editor. The assembler generates an alphabetized symbol table, a cross-reference table, and it is capable of assembling over 1900 lines per minute. The editor has 18 commands and 10 text buffers. APEX costs $99 from Apparat Inc, 4401 S Tamarac Pky, Denver CO 80237, (303) 741-1778.

Circle 401 on inquiry card

TRS-80 Program Generator

The program Generate writes a three-program system (a selector, input/edit module, and print program) that will maintain a key file. The input/edit module allows the operator to add, delete, or change records and their keys in the file. The print program selects the fields to be printed, and it selects the range to appear on the listing. The program comes on a 5-inch floppy disk with instructions that include suggested applications. Generate requires a TRS-80 Model I Level II system with at least two disk drives and 32 K bytes of memory. A printer is optional, because the program can be user-adapted for a display screen. The program costs $100 from Paul Swanson, c/o DataWorks Inc, 97 Jackson St, Cambridge MA 02140, (617) 492-4305.

Circle 402 on inquiry card

OSI Software

HEXDOS 2.3 is a disk operating system designed for use with OSI (Ohio Scientific) BASIC in ROM (read-only memory). Residing in 2 K bytes of memory, HEXDOS supports a real-time clock, named floppy-disk files, trace and single-stepping of programs, a tone generator, multiple data files, editing capabilities, chaining of programs, and an interactive disassembler. The price for a 5-inch floppy disk and manual is $27.50.

FOCAL-65 is DEC's (Digital Equipment Corporation) powerful, high-level language adapted for the 6502. It constructs programs that are more compact than similar BASIC programs. All in 8 K bytes, FOCAL-65 features 9-digit floating-point arithmetic and string handling functions. This language is available on a 5-inch floppy disk or cassette with a manual for $49.50. Information on either software package can be obtained by writing The 6502 Program Exchange, 2920 W Moana, Reno NV 89509.

Circle 403 on inquiry card

Where Do New Products Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first-in first-out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

What's New?

SOFTWARE

Statistics Program



Microstat is a statistics package for CP/M systems using BASIC-80. The program is chiefly oriented towards files. It includes a data-management subsystem that allows users to list, edit, destroy, delete, augment, sort, rank order, lag, move, merge, and transform data into new data. Programs are provided for statistical analysis in descriptive statistics, hypothesis testing, analysis of variance, scatterplots, correlation analysis, simple and multiple regression, time series, and more. Microstat requires 48 K bytes of memory, a single-density 8-inch floppy-disk drive, and CP/M with BASIC-80. The program is available for the North Star disk operating system and BASIC; two disk drives are recommended. The cost is $250. A manual is $15. For further information, contact Ecosoft, POB 68602, Indianapolis IN 46268, (317) 283-8883.

Circle 404 on inquiry card

CP/M 2.2 for OSI C3 Systems

Known as CP/M2, this version of CP/M 2.2 is compatible with the original OSI (Ohio Scientific) C3 computer's CP/M format. All software and data on current OSI CP/M disks can be retained. With CP/M2, disk read operations are four to five times faster, and disk write operations can be as much as fifty times faster. The C3 CP/M2 compensates for 2 or 4 MHz microprocessor operation. The system also includes a CP/M disk-to-disk copy routine, a memory test program for the Z80, and I/O (input/output) drivers for most OSI peripherals. CP/M2 is available for $200 from Lifeboat Associates, 1651 Third Ave, New York NY 10028, (212) 860-0300.

Circle 405 on inquiry card

CP/Modem

Information Engineering has released CP/Modem. This package can send files between a CP/M computer and another computer, make a CP/M system function as a terminal to a remote computer, and allow users to operate, control, and perform diagnostics on remote CP/M systems. A high-level protocol supports error checking and automatic retries during file transfers. File transfer is block-oriented. CP/M modem has three operating modes: terminal, termecho, and datalink, plus a transitional state command mode. The program has a split-screen display, with status indicators for data rates, mode, parity, stop bits, word length, data type, and file name. The software supports data rates to 19.2 k bps and has full- and half-duplex modes. The CP/M Modem software package is distributed as object code on 5- and 8-inch floppy disks in CP/M format. A single microprocessor license is $300. The manual is $15. Mainframe support for Digital Equipment Corporation's DECsystem-10* is $1500. For further information, contact Information Engineering, 8 Bay Rd, POB 305, Newmarket NH 03857, (603) 659-5891.

Circle 406 on inquiry card

muLISP/muSTAR-80 AI Development System

The muLISP-80 pseudocode LISP interpreter can provide the basis for AI (artificial intelligence) projects. muSTAR-80 provides a resident display-oriented editor and debugging facility. A pseudocode compiler in muLISP-80 produces extremely compact code. Dynamic allocation of data-space boundaries maximizes the use of programmable memory storage. Linkage to machine-language subroutines is easily performed. These two programs work on 8080-, 8085-, and Z80-based systems. The system includes a library file that contains utility functions which provide examples of muLISP function definitions. Supplied with the system are several games, including a muLISP implementation of the Eliza (Doctor) program. Microsoft and Lifeboat Associates are offering muLISP/muSTAR-80 for a variety of microcomputers including those using the TRSDOS and CP/M operating systems, or equivalent systems. For details, contact Microsoft, 10800 NE 8th, Suite 819, Bellevue WA 98004, or Lifeboat Associates, 1651 Third Ave, New York NY 10028.

Circle 407 on inquiry card

CP/M-86

Digital Research's CP/M-86 operating system is for any microcomputer that is based upon the Intel 8086/8088 microprocessors. CP/M-86 is a single-user operating system designed to take advantage of the 8086's address space and speed, while expanding upon the facilities of CP/M. For compatibility, the file format of CP/M 2 has been retained. CP/M-86 can function as a slave node in a CP/NET network. Logical and hardware-dependent portions of the operating system are modularized. For more information, write to Harold Elgie, c/o Digital Research, POB 579, 801 Lighthouse Ave, Pacific Grove CA 93950, (408) 649-3896.

Circle 408 on inquiry card



SOFTWARE

VisiCalc Plus for the HP-85 Microcomputer

VisiCalc Plus is an enhancement of the calculating and bookkeeping VisiCalc program for the Hewlett-Packard HP-85 microcomputer. The program is useful for forecasting, budgeting, and other business and technical applications. The enhancements include a graphics program that lets users turn VisiCalc tables into four-color graphics. Line charts, bar charts, pie charts, and curve-fitting graphs are available along with graphics features, such as six styles of lines and hatchings. Twenty extra financial, statistical, and mathematics functions include internal rate of return, standard deviation, and variance. A "Help" facility displays information about a keyword typed by the user. VisiCalc Plus comes on tape cartridges and floppy disks for $200. A 16 K-byte memory module is required to run the program. For information, contact Inquiries Manager, Hewlett-Packard Company, 1507 Page Mill Rd, Palo Alto CA 94304, (415) 857-1501.

Circle 409 on inquiry card

TRS-80 Cash Register Software

Computer Consultants', 312 Hoyt St, Dunkirk NY 14048, (716) 366-0766, TRS-POS allows a TRS-80 Level II to function as a point-of-sale terminal system. Some TRS-POS features are its English operator prompting and error messages and an electronic memo pad. With TRS-POS, the businessperson can keep track of sales commissions and inventory. The system can be user-configured to suit individual needs. The TRS-POS system comes in a 16 K-byte package that allows 50 user-definable departments and in a 32 K-byte package that allows 110 departments. TRS-POS prices begin at $100.

Circle 410 on inquiry card

The Store Manager

High Technology Inc, 8001 N Classen Blvd, POB 14665, Oklahoma City OK 73113, (405) 840-9900, is distributing The Store Manager. This program is a point-of-sale and inventory-control system. It produces purchase orders, receiving reports, invoices, packing slips, and quotations. Sales totals and inventory-management reports are also handled. The program is useful for managing small businesses. The Store Manager runs on a 48 K-byte Apple II with at least two floppy-disk drives. The suggested retail price is $250.

Circle 411 on inquiry card

Pascal Express Utility Package

This package of utilities and other software for the Apple II is designed to help experienced BASIC users become acquainted with UCSD Pascal. Four sections simplify I/O (input/output) formatting; allow access and change in the disk directory from a Pascal program; perform integer, string, and real number conversions; and support files of variable-length records. Also included are Pascal demonstrations with listings on BASIC equivalents, a routine to view disk files in ASCII or hexadecimal code, a text formatter, a program to maintain a variable-length data file, and a Happy Birthday surprise. A manual, a disk, and the source-code files cost $45 from Software Express, POB 50453, Palo Alto CA 94303, (415) 856-9244.

Circle 412 on inquiry card

Multi-User, Multitasking Disk Operating System

The Cromix operating system supports Cromemco's floppy- and hard-disk drives. It includes multiple hierarchical directories and subdirectories; compatible I/O (input/output), which supports user redirection of I/O; a shell-sort program; a password security system; data and time support; file buffers; and swapping-free execution of tasks through bank selection. The Cromix operating system includes a CDOS Simulator that allows CDOS programs to be executed directly. Cromix requires a minimum memory of 128 K bytes. A single 64 K-byte memory card must be added for each additional user or task. Cromix is available on 5- or 8-inch floppy disks for $295. Inquiries can be addressed to Cromemco Inc, 280 Bernardo Ave, Mountain View CA 94043, (415) 964-7400.

Circle 413 on inquiry card

The Prisoner

The Prisoner was inspired by the television series of the 1960s. Consisting of twenty interlinked games, the program places the player on an island housing a psychological prison camp. The player's task is to escape both the island and its attempts to extract information from him. The Prisoner requires an Apple computer with 48 K bytes and a single disk drive. The program lists for $29.95. Contact Edu-Ware Services Inc, 22035 Burbank Blvd, #223, Woodland Hills CA 91367, (213) 346-6783.

Circle 414 on inquiry card

Track Orders Daily

CORP is a customer-order review program for a salesperson in any small- to medium-sized business. Designed with the TRS-80 Models I and II in mind, CORP tracks the daily orders of individual salespersons. CORP allows management personnel to monitor a salesman's performance and to know which customers have not placed an order since any particular date. Different criteria for selecting reports on customer orders can be specified. CORP contains updating facilities and diagnostics. It is available on a 5-inch floppy disk, including documentation, for $195 from B & B Software, POB 2090, Ann Arbor MI 48106.

Circle 415 on inquiry card

Apple II Word Processor

Computer Solutions, 6 Maize Pl, Mansfield, Queensland 4122, Australia, has announced its word-processor software for the Apple II. The software allows true uppercase and lowercase on the Apple. Full "mailmerge" facilities are included in the system. The software and manual are priced at $295.

Circle 416 on inquiry card

TFORTH

TFORTH is a procedural language that specifies process rather than desired result. It produces a compact code that can be executed at high speeds. TFORTH uses a stack for parameters and a dictionary for words that allows new words to be created in terms of predefined words. New data types and new processes can become part of the language. TFORTH can be used to develop new languages, provide simple control of devices, and implement tasks requiring monitoring and decision. Certain hardware modifications can be eliminated by using TFORTH to do digital logic or data reduction. TFORTH is designed for the TRS-80 with 16 K bytes of programmable memory and a single floppy-disk drive using either TRS-DOS or NEWDOS. It costs $129.95 or $136.95, depending on additions. Contact Sirius Systems, 7528 Oak Ridge Hwy, Knoxville TN 37921, (615) 693-6583.

Circle 417 on inquiry card

What's New?

PUBLICATIONS and MISCELLANEOUS

Sinclair ZX80 Users Magazine

Sync is a bimonthly magazine for users of the Sinclair ZX80 microcomputer. The publication carries articles about how best to use the features of the ZX80. Sync also carries financial analysis, statistics, simulations, and games. Sync has published program listings for Acey Ducey, Hurkle, and the Nicomachus "boomerang" puzzle. Reviews of software, peripherals, and books related to the ZX80 are also provided. Subscriptions are $10 per year from Sync, 39 E Hanover Ave, Morris Plains NJ 07950, (201) 540-0445.

Circle 418 on inquiry card

Educational Catalog

Marck publishes a free mail-order educational software catalog that has descriptions of hundreds of programs for small computers. Related products and articles are also included. Contact Marck, 280 Linden Ave, Branford CT 06405, (203) 481-3271.

Circle 419 on inquiry card

Article Index

Magdex Research has announced a quarterly publication entitled The Article Index. The Index covers many articles, short notes, and other information contained in the top ten microcomputing journals. The Index is divided into two sections. The first section categorically lists all article titles and short paragraph locations. The second lists references by keyword. In all, The Index has over 11,000 references. Subscription rates are $7.50 for one year, $13.50 for two, $18 for three, and lifetime rates are $45. Charter subscribers receive indexes for 1977 thru 1980. Contact Magdex Research, POB 706, North Plains OR 97133.

Circle 420 on inquiry card

PGI Wholesale Publishes Price Card

PGI Wholesale has published a quick-reference price list. The guide contains pricing information on microcomputer products from more than thirty-five manufacturers, including the Archives Business Computer. Contact PGI Wholesale, 1425 W 12th Pl, Tempe AZ 85281, (800) 528-1415 or (800) 528-6450.

Circle 421 on inquiry card

Design Aids for Electronics



This catalog has been designed for engineers and draftsmen in the electronics industry. It features templates containing the latest in logic and schematic symbology and component layout patterns. All symbols or patterns comply with ANSI, IEEE, IPC, and MIL-STD specifications. The catalog is available from Tangent Template Inc, POB 20704, San Diego CA 92120, (714) 292-0046.

Circle 422 on inquiry card

Continuous Forms

Discount Data Forms Inc, 407 Eisenhower Ln S, Lombard IL 60148, (312) 629-6850, is marketing a line of continuous computer forms. The product line includes stock invoices, statements, bills of lading, purchase orders, and voucher, payroll, and personal checks. A brochure and samples are available from the company free of charge.

Circle 423 on inquiry card

Word Processing Report

The Small Systems Group has begun publication of a series of product evaluation reports. The first report "Word Processing on Personal Computers," is now available. This report introduces word processing with sections on software, hardware, and applications. It describes Auto Scribe, Electric Pencil, Magic Wand, and WordStar word-processing programs. Single copies of the report are available for $10 from the Small Systems Group, POB 5429, Santa Monica CA 90405, (213) 392-1234.

Circle 424 on inquiry card

Education Catalog

The Micro Software Division of Charles Mann & Associates has compiled the Education Catalog. This catalog details educational programs for the Apple II, TRS-80, and TI 99/4 microcomputers. The programs can be used to develop customized teaching programs, to teach BASIC programming, and to reduce administrative tasks. Grade reporting, class scheduling, and record-keeping programs are also described. These and other programs have been designed by Charles Mann & Associates, which is located at 7594 San Remo Trl, Yucca Valley CA 92284, (714) 365-9718.

Circle 425 on inquiry card

Dual-Purpose Computer Checks from NEBS

The 9022 computer checks are designed to be used for payroll or accounts payable. The stub portion is blank except for the customer's name and the consecutive check number. The forms are available in quantities as low as 500 for $29.95. Prices include printing the customer's name and address, bank name and number, consecutive numbering, and inclusion of an MICR code line. Contact NEBS Computer Forms, 78 Hollis St, Groton MA 01450, (800) 225-9550, in Massachusetts (800) 922-8560.

Circle 426 on inquiry card

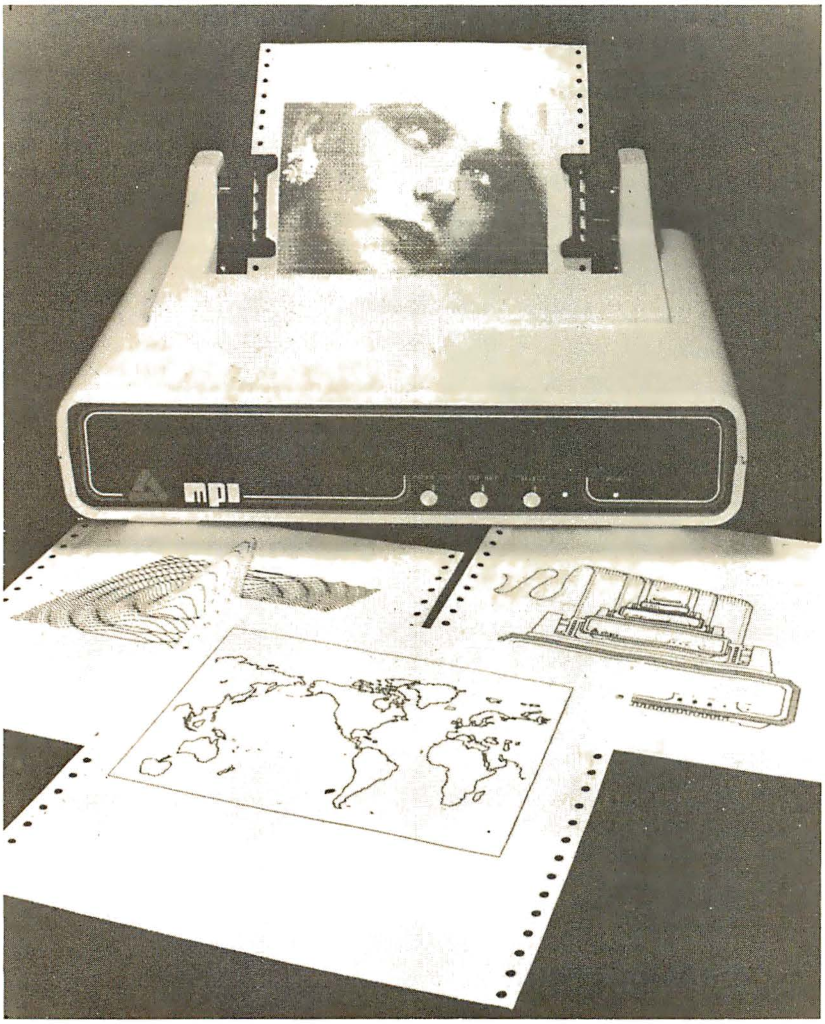
Speech Synthesis Evaluation Board

An assembled circuit board for evaluating the operation and application of the Digitalker speech synthesis integrated-circuit set is available from National Semiconductor Corporation, 2900 Semiconductor Dr, Santa Clara CA 95051, (408) 737-5000. The DT1000 board requires a single 9 V power supply and a speaker for operation. It contains National Semiconductor's speech processor circuit, two speech ROMs (read-only memories), output filter, audio amplifier, keyboard, a microcontroller, and an EPROM (erasable programmable read-only memory). The speech ROMs enable users to link words consisting of numbers and letters, nouns, verbs, tones, and silence durations into phrases and sentences. National Semiconductor's Digitalker speech-synthesis systems utilize human speech and voice waveforms for digital encoding and storage. The DT1000 is available for $495.

Circle 427 on inquiry card

What's New?

PERIPHERALS



MPI's Model 88G Printer

The Model 88G impact matrix printer features 100 cps (character per second) bidirectional or unidirectional printing, with throughput rates of up to 150 lines per minute. A full uppercase and lowercase 96-character ASCII (American Standard Code for Information Interchange) set is printed in a 7 by 7 matrix, with print line formats of 80, 96, or 132 columns per line over an 8-inch print area. Double-width characters are software-selectable in any of the font styles or character densities. A high-resolution, dot-addressable graphics option can be added for plotting, printing of screen graphics, drawing of illustrations, or producing special characters and identification marks. Forms handling is carried out with a paper-feed system that can accept fanfold forms from 1 to 9½ inches in width. Sixteen selectable form lengths and a "skip-over-perf" feature are provided. The printer uses continuous-loop ribbon cartridges, and it has an RS-232C, and a parallel interface. It can also be interfaced to devices with an IEEE-488 bus output. A detachable roll paper holder, single-sheet feeder, and a 2 K-byte buffer are available. The Model 88G with the graphics option lists for $799. Contact MPI, 2099 W 2200 South, Salt Lake City UT 84119, (801) 973-6053.

Circle 432 on inquiry card

Enhanced AIO Board from SSM

The SSM AIO serial and parallel Apple II interface board has been enhanced. The AIO now interfaces with serial and parallel devices simultaneously under Pascal. The RS-232 serial interface has three handshaking lines and eight data rates from 110 to 9600 bps (bits per second). Additional data rates are possible through external input. Two bidirectional 8-bit parallel ports are provided with four additional interrupt and handshaking lines, as well as interface configurations that are progammable and software controlled. The AIO includes firmware for controlling serial interface and software for driving parallel printers. It includes the cable assemblies necessary for parallel and serial interfaces, and a user's manual. Contact SSM Microcomputer Products, 2190 Paragon Dr, San Jose CA 95131, (408) 946-7400.

Circle 433 on inquiry card

PET Graphic Interface Board

The MTU K-1008-6 PET Graphic Interface adds high-resolution graphics to the PET computer. The expansion board features five ROM (read-only memory) sockets that can be set at the same or different addresses with software control of whichever sockets are enabled. The board provides user control over a matrix of 64,000 dots. The device serves as an 8 K-byte expansion memory when not used for graphics. On-board expansion allows use with an optional light pen. Graphics software is also offered. The board is priced at $320; connectors for older model PETs are $35; and connectors for the newer model PETs are $59. For more information, contact Micro Technology Unltd, 2806 Hillsborough St, POB 12106, Raleigh NC 27605, (919) 833-1458.

Circle 434 on inquiry card

Turn the TRS-80 into a Time-Sharing Terminal

TERMCOM is a hardware and software package that turns the TRS-80 into a time-sharing terminal. TERMCOM hardware allows Level II users to utilize time-sharing systems without acquiring the Expansion Interface and RS-232 board. The software includes full paging capabilities, making it possible to store several screens of data, which are accessible at any time. The TERMCOM program allows lines to be scrolled off the screen while still remaining accessible in memory. The wrap-on-blank capability breaks long lines into two lines between words. For tabular materials, automatic left- or right-justification may be specified. The TERMCOM package can lock information on the top or bottom of the screen, while keeping the other portion free for normal use. Other features include memory buffer-overflow protection, uploading and downloading of files from disk, and variable rates for file loading to match other systems used in time-sharing. It is compatible with all Radio Shack supplied products. The package costs $169.95 from Statcom Corporation, 5758 Balcones Dr, Suite 202, Austin TX 78731, (512) 451-0221.

Circle 435 on inquiry card

What's New?

SYSTEMS

System Zero from Cromemco

Cromemco's System Zero computer, an S-100 bus microcomputer, includes a Z80A-based single-card computer, 1 K bytes of programmble memory, 3 K bytes of Control BASIC in ROM (read-only memory), and three extra slots on the S-100 bus. The system is designed for ROM programs, but it can be expanded by adding memory and I/O cards. The System Zero/D is available with floppy-disk drives, the Z80A board, 64 K bytes of programmable memory, and a disk-controller card. The controller contains RDOS-2, a disk operating system that reads and writes single- and double-sided and single- and double-density floppy disks, and also contains a systems diagnostic routine. Software for the System Zero includes RPG II, FORTRAN, COBOL, 16 and 32 K Structured BASIC, LISP, word-processing, database management, business software, and operating systems. The System Zero list price is $995, and the Zero/D has a list price of $2995. The Model DDF dual-disk drive is available for $1295. Contact Cromemco Inc, 280 Bernardo Ave, Mountain View CA 94043, (415) 964-7400.

Circle 429 on inquiry card

Microcomputers with High-Resolution Graphics Options

The Dynamic Blackboard microcomputer systems use the S-100 bus and a Z80A microprocessor. The systems support either black-and-white, gray shades, or full-color graphics at a resolution of 640 by 512 pixels. CP/M-compatible graphics software and Tektronix-emulation software are also available. Graphics printers are supported. Three Dynamic Blackboard systems are available: the Brilliant Terminal, the Standalone System, and the Network Configuration. The Brilliant Terminal is for larger mainframes, and it can be used as a stand-alone computer and color graphics terminal. The Standalone System has a graphics option, and the Network Configuration allows several microcomputers to share a disk subsystem and a printer. Prices for the single computers are in the $10,000 to $15,000 range. For more information, contact the Cambridge Development Laboratory, 36 Pleasant St, Watertown MA 02172, (617) 926-0869.

Circle 430 on inquiry card

SSM's Z80 Microprocessor Board

SSM Microcomputer Products, 2190 Paragon Dr, San Jose CA 95131, (408) 946-7400, has announced the CB2 Z80 microprocessor board. The CB2 is capable of operating at 2 or 4 MHz, and it includes sockets for two 2716 or 2732 EPROMs (erasable programmable read-only memories) or HM6116 2 K-byte programmable memories. The memory sockets can be enabled or disabled. Run/stop and single/step switches are also included on the board to permit system evaluation without the need for a front panel.

The CB2 also features a firmware-vector jump and an output port to control eight extended address lines. Memory can be expanded to more than 64 K bytes. Board jumpers can generate the proposed IEEE (Institute of Electrical and Electronics Engineers) S-100 signals. The board can emulate 8080 I/O (input/output) addressing, and it is provided with an 8-bit output port for extended addressing. The CB2 requires +8 V at 0.75 A.

Circle 431 on inquiry card

What's New?

PERIPHERALS

Ampex's Video Terminal



Ampex Corporation, 200 N Nash St, El Segundo CA 90245, (213) 640-0150, has entered the video-terminal market with the Ampex Dialogue 80, a buffered editing terminal that operates in conversational or block modes. The terminal features a detached keyboard, lowercase descenders, and a 25th display line that allows operators to determine the status of various operational modes and note errors. Dialogue 80 has an RS-232C asynchronous interface that operates at half- or full-duplex and a standard serial printer interface. Scrolling is a standard feature in the conversational mode. The display features 24 lines by 80 characters. The format is a 6 by 8 dot matrix in a 7 by 10 field. The terminal has reverse video, blink, blank, underline, and half-intensity features. Protected fields appear at half-intensity and cannot be changed when in the protect mode. Editing features include erase, insert, and delete character and line functions. The 128 symbols include 96 ASCII (American Standard Code for Information Interchange) characters, 21 control characters, and 11 characters to support line drawings. Constants, screen formats, or command sequences for the terminal and host computer are user-programmable. A 2 K-byte expansion memory is optional. The Dialogue 80 is $1149 in single units.

Circle 436 on inquiry card

Portable Bar-Code Reader



The Model 9400 bar-code reader is designed for in-house data collection. A bar-code alphanumeric keypad is provided for manual data entry. Bar-code labels up to 32 characters long may be scanned. The memory has a 20 K-byte capacity. The user may select between a belt clip and a shoulder strap to carry the unit. The 9400 may be operated on-line in the terminal mode without affecting data in its memory, and a real-time clock feature is available to store time and date information. Previously stored data can be reviewed and edited. The Model 9401 Charger/Interface unit provides two RS-232C connectors. Contact Wade T Nixdorff at Interface Mechanisms Inc, POB N, Lynnwood WA 98036, (206) 743-7036.

Circle 437 on inquiry card

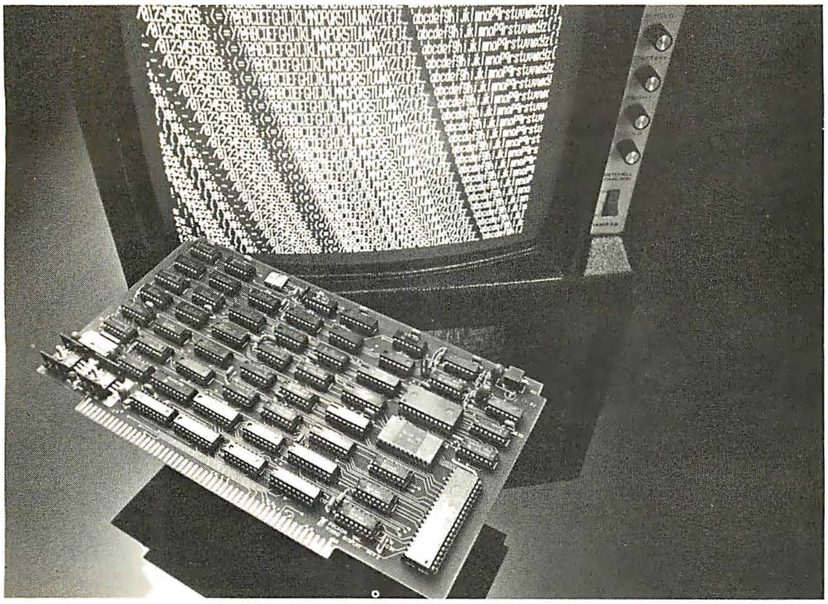
Info 2000's Performer Systems

The Performer Systems are an entire line of business microcomputers offering word processing, billing, general accounting, data communications, and recordkeeping functions. One model, the Standard Performer, uses 5-inch floppy-disk drives that store 400 K bytes of memory (about 200 typewritten pages). Another model, the Maxi Performer, uses 8-inch drives that can hold 1.25 megabytes (about 600 typewritten pages). As a word processor, either Performer can handle documents such as contracts, engineering reports, and ordinary business correspondence. Functions include true proportional spacing, underlining, boldface, justification, centering, indentation, and more. Typical applications include inventory, purchase or sales orders, court or appointment calendars, and customer or prospective customer lists. Additionally, mailing labels and envelopes can be prepared. Facilities include complex sort sequences and selection criteria, full-formula arithmetic, and multilevel subtotals and page breaks. Accounting capabilities include accounts receivable, accounts payable, general ledger, and financial statement preparation. A client-billing package for attorneys, accountants, consultants, and other professionals is available. The Performer also supports the WESTLAW automated legal-research system and the New York Times INFOBANK services. The systems are priced between $12,00 and $18,000, or they may be leased for $400 to $600 per month. Contact Info 2000 Corporation, 20620 S Leapwood Ave, Carson CA 90746, (213) 532-1702.

Circle 438 on inquiry card

PERIPHERALS

On-Board Screen Memory with the V-100 Video Controller



The V-100 video-controller board, with 2 K bytes of on-board screen memory, can reduce central-processor overhead. It is fully compatible with the IEEE's (Institue of Electrical and Electronics Engineers) S-100 bus standard. The V-100 can be I/O (input/output) mapped, so that the screen memory does not take up space in the user's system. Interfacing to the video monitor is handled by writing control information to the V-100's logic. The board can display 24 lines by 80 characters in 7 by 9 dot-matrix formats. Fonts are available for standard ASCII (American Standard Code for Information Interchange), or French, German, or Japanese characters. It also provides 16 user-programmable graphic characters. The board can accept data at 2 megabytes per second, allowing data to be transferred to the screen at the processor speed. A compatible software package, VEDIT, allows screen editing with full cursor control, block moves, file handling, and more. It requires a CP/M-compatible operating system. The V-100 is priced at $450 per board, and VEDIT is $110. Contact Piiceon Inc, OEM Division, 2350 Bering Dr, San Jose CA 95112. CompuView Products Inc, the maker of VEDIT, is located at 1531 Jones Dr, Ann Arbor MI 48107. Circle 439 on inquiry card

TRS-80 Printer and Memory Expansion Module

This printer/memory expansion module can add 16 K or 32 K bytes of dynamic programmable memory to a TRS-80 microcomputer. It can also drive Microtek's MT-80P dot-matrix printer or any Centronics-compatible printer. The module is housed in an aluminum case that sits under the video display. It is available in three configurations: the MT-32A, without memory for $99.50; the MT-32B, with 16 K bytes of programmable memory for $159.50; or the MT-32C with 32 K bytes of memory for $199.50. For further information, contact Microtek Inc, 9514 Chesapeake Dr, San Diego CA 92123, (800) 841-1081, in California (714) 278-0630.

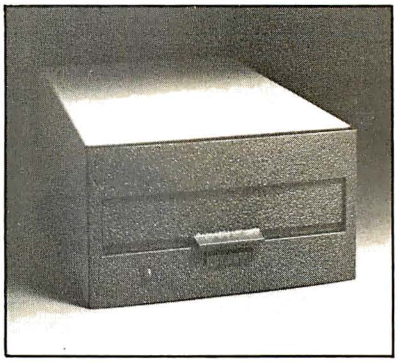
Circle 440 on inquiry card

High-Resolution H-8 Color Graphics

The Heathkit H-8 is now able to generate high-resolution color graphics with the addition of this color graphics board. The board is fully compatible with the H-8. It contains 8 K bytes of static programmable memory, which is address dip-switch selectable. On-board RF (radio frequency) modulation is included for output to color or black-and-white television. The board can generate eight graphic display modes, eight colors, and features a resolution of 256 by 192 pixels. It is available in kit form for $379, or assembled and tested for $479. Request complete details from Owen Phairis Computer Products, POB 3400, Big Bear Lake CA 92315, (714) 585-8354.

Circle 441 on inquiry card

Apple Plug-Compatible Floppy-Disk Drive



The A-70 and A-40 floppy-disk drives have a jumper-selectable boot PROM (programmable read-only memory) for 13- or 16-sector Integer BASIC- or Pascal-language cards as standard features. The A-40 drive provides 40 tracks of storage and track-to-track speeds of 5 ms for $495 for the first unit and $395 for additional units. The A-70 has the same features as the A-40; however, it provides 70 tracks of storage and is priced at $675 for the first unit and $575 for additional units. For more information, contact Micro-Sci, 1405 E Chapman, Suite E, Orange CA 92666, (714) 997-9260. Circle 442 on inquiry card

Power Supply on a Card

An 8 W power supply has been introduced by Miller Technology, 16930 Sheldon Rd, Los Gatos CA 95030, (408) 395-2999. The PS-80 supplies +5 V at 800 mA, +12 V at 150 mA, and −5 and −12 V at 150 mA. The power supply card is 11.5 by 16.5 cm (4½ by 6½ inches), including the 22-pin edge connector. A standard fuse is supplied. A 115 V AC and a power-line switch can be connected with the supplied connectors. The PS-80 is available in kit form for $35 or assembled and tested for $60.

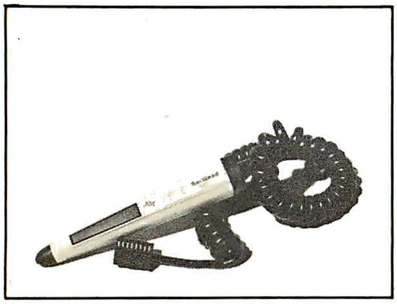
Circle 443 on inquiry card

PS-8 Power Supply

Cromemco's PS-8 power supply is designed to power microcomputer systems configured with the Cromemco CC-8 eight-slot card cage and any combination of S-100 boards. The PS-8 provides one output of +7.5V/12A, +14.5V/2.5A, and −14.5V/1.0A. A system reset switch is built into the power supply. The supply is designed for 110 or 220 V operation. Ambient temperature operation is from 0 to 55° C. The power supply is available from Cromemco Inc, 280 Bernardo Ave, Mountain View CA 94043, (415) 964-7400.

Circle 444 on inquiry card

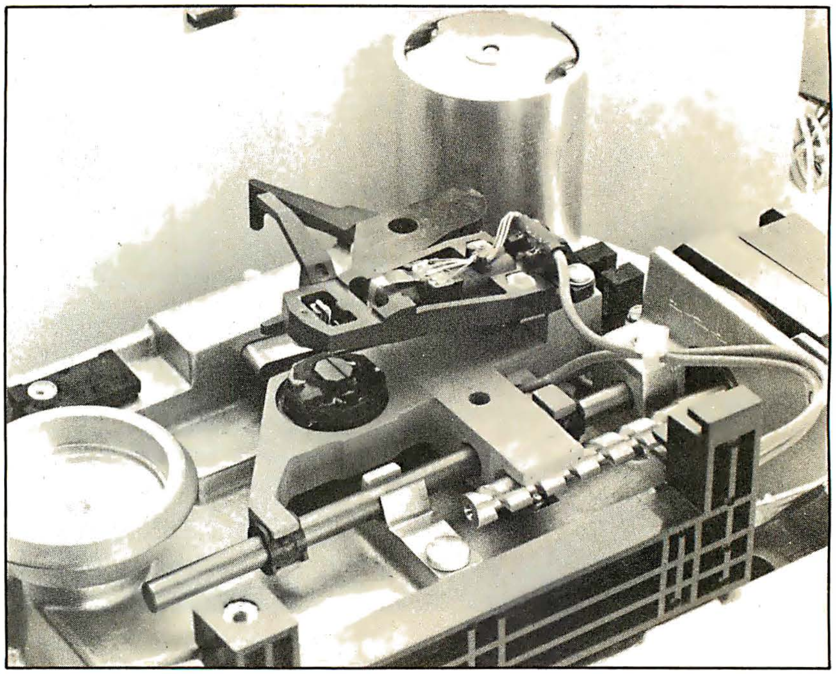
Bar-Code Reader for the Apple



The ABT BarWand plugs into the Apple II or III and reads standard bar code. ABT has also developed a program to read UPC (Universal Product Code). Additional programs have also been created to print and read ABT's own LabelCode and Applesoft programs in Paperbyte Code. The latter two programs are forms of bar code that can be printed with a dot-matrix printer. When bar code is entered through the BarWand, a scan tone sounds indicating that the last line of data was correctly read. The suggested retail price of $195 includes the BarWand and a demonstration floppy disk of the UPC, LabelCode, and Paperbyte programs. A ROM (read-only memory) multiprotocol BarWand I/O (input/output) board is also available. For more information, contact Advanced Business Technology Inc, 12333 Saratoga-Sunnyvale Rd, Saratoga CA 95070, (408) 446-2013.

Circle 445 on inquiry card

96 Tracks Per Inch 5-Inch Floppy-Disk Drives



The SA410 (single-sided) and the SA460 (double-sided) drives feature unformatted capacities of 500 K bytes and 1 megabyte, respectively, using double-density recording. For faster access time, the drives incorporate a helical cam v-groove lead screw for head positioning. The drives also use a DC spindle motor that allows the drive to be shut down when not in use. The drives can back up 5- to 10-megabyte hard disks, including Shugart's SA400 and 450 drives. Other features of the drives include a track-to-track access time of 6 ms, a tachometer that provides servo speed control, and an activity indicator. A maximum recording density of 5876 bits per inch is another feature. Mean time between failures is 8000 power-on hours. The SA410 costs $325 in OEM (original equipment manufacturer) quantities of 100; the SA460 is priced at $400 in the same quantities. For further details, contact Shugart Associates, 475 Oakmead Pky, Sunnyvale CA 94086, (408) 733-0100.

Circle 447 on inquiry card

SSI Band Printer Has 900 Lines Per Minute

SSI's B-900 printer features several bands and a 48-, 64-, and 96-character set, plus specialized and foreign character sets. The print speed is 1100 lpm (lines per minute) at 48 characters, 900 lpm at 64 characters, and 600 lpm at 96 characters. Vertical spacing for multiple-form lengths, provisions for up to five copies, a diagnostic display, paper-out detect sensors, and print-to-bottom of the form capabilities are included. The B-900 is compatible with Digital Equipment Corporation's DECsystems 10 and 20, Hewlett-Packard, Data General, SEL, Texas Instruments, Burroughs, and other minicomputers and mainframes. Parallel interfacing is standard, and SSI also supplies serial synchronous and asynchronous interfaces. Contact Southern Systems Inc, 2841 Cypress Creek Rd, Ft Lauderdale FL 33309, (800) 327-5602, in Florida (305) 979-1000.

Circle 446 on inquiry card

Apple II Nine-Voice Music Synthesizer

You can turn your microcomputer into a nine-voice music synthesizer with the AM-II package from Peripherals Plus. The AM-II package consists of the software and a board that plugs into the Apple II. The $198 AM-II allows users to compose music with two game paddles. The music is displayed as notes on a music staff. From a menu at the bottom of the screen, users can select notes from a six-octave range, along with duration and other characteristics. The music is displayed with graphic animation during playback. Using the keyboard, the user has control of key, tempo, envelope values and duration, waveform, and length. The AM-II is available from Peripherals Plus, 119 Maple Ave, Morristown NJ 07960, (800) 631-8112, in New Jersey (201) 267-4558.

Circle 448 on inquiry card

Link Winchester ST-506 Disk Drives to GPIB Computers

The MSC-9305 controller provides on-board interfacing to Seagate Technology's ST-506 disk drives, and incorporates the GPIB interface standard for attachment with computers using the GPIB standard bus. This will allow ST-506 drives to work with the PET, Xerox 1350, and the Hewlett-Packard HP-85 system. It can also be used with computers accommodating GPIB adaptors, such as the Apple II, DEC (Digital Equipment Corporation) systems, Prolog, and with computers using Intel's Multibus. The controller employs an integrated data separator, automatic error correction, full-sector data buffer, and automatic position verification. The price of the MSC-9305 is $700 from Microcomputer Systems Corporation, 432 Lakeside Dr, Sunnyvale CA 94086, (408) 733-4200.

Circle 449 on inquiry card

What's New?

PERIPHERALS

Touch-Input Video Display



The VuePoint touch-input terminal is 7 cm (2¾ inches) thick and has a 12-line by 40-character flat-panel display. VuePoint's controller provides for up to fifty-one pages of information. A response is sent to the host computer by finger contact to any one of 240 discrete touch-sensitive locations of the display screen. Communication is by selectable 300 to 19,200 bps (bits per second) data rates via an RS-232 interface. The controller for the display can be placed up to ten feet from the screen. Prices begin at $3500. For more information, contact General Digital Corporation, 700 Burnside Ave, East Hartford CT 06108, (203) 289-7398.

Circle 450 on inquiry card

Atari Memory Expansion Kit Has Supporting Software

This memory expansion kit will upgrade Atari 8 K-byte programmable memory boards to 16 K bytes. The kit provides five times more program space in high-resolution graphics and allows access to higher resolution graphics. The $79.95 price includes all hardware and instructions. Software support includes graphics programs like Plot & Draw, which generates graphics quickly while saving data for incorporation into BASIC programs. For more information, contact Mosaic Electronics, POB 748, Oregon City OR 97045, (503) 655-9574.

Circle 451 on inquiry card

The Model 460 Paper Tiger Printer

The Model 460 printer has throughput speeds of up to 160 cps (characters per second), can produce letter-quality print, and provides a variety of programmable print-control functions. The 460 employs a horizontal and vertical overlay dot-matrix character formation technique and a 9-wire bidirectional print head. Control functions include proportional spacing, bold text printing, and print densities of 10, 12, or 16.7 characters per inch. Automatic text justification, programmable horizontal and vertical tabbing, reverse paper feed, and positioning of characters to $\frac{1}{120}$ of an inch are other control features of the printer. It can print in 80-, 96-, and 132-column formats. Foreign or custom character sets can optionally be added to or replace the standard ASCII (American Standard Code for Information Interchange) character set; the printer allows uppercase and lowercase characters with descenders. Forms control features include programmable top and bottom of form, perforation skip, and vertical and horizontal tabs. A microprocessor provides an automatic memory, electronics, and print capability test. A 2 K-byte bu fer and the ability to print graphics such as bar codes, block letters, and illustrations are included. The 460 has an RS-232C serial and a Centronics-compatible parallel interface. Data rates from 110 to 9600 bps are switch-selectable. The price for the Model 460 Paper Tiger printer is $1295 from Integral Data Systems Inc, Milford NH 03055, (603) 673-9100.

Circle 452 on inquiry card

Three HP-85 Interfaces

The three HP-85 interfaces are a serial (RS-232C-compatible) interface card, a general-purpose parallel I/O (input/output), and a BCD (binary-coded decimal) card. The serial-interface card provides the HP-85 with bit-serial asynchronous data communication capability, with support for RS-232C and current loop operations. Features include: user-programmable data rates, parity, bits per character, and stop bits without changing physical switch settings. Other features include full-duplex with I/O buffers, and a 20 mA current loop. This card allows printers, modems, and other peripherals to be used with the HP-85.

The general-purpose interface card provides bit-parallel byte- and word-oriented interfacing. Two bidirectional ports and two output-only ports are on the card. The card can be configured as four separate 8-bit ports, two 16-bit ports, or two 8-bit and one 16-bit ports. Paper-tape readers, punchers, and card readers can be interfaced with this card.

The BCD card permits all data to be present simultaneously on a set of 48 wires. Instruments can output up to eleven BCD digits; two BCD instruments can be accommodated with the card. Typical applications for this card are in voltmeters, counters, medical equipment, and electronic scales. The serial-interface card is $395 and the other cards are $495. Contact the Inquiries Manager, Hewlett-Packard Company, 1507 Page Mill Rd, Palo Alto CA 94304, (415) 857-1501.

Circle 453 on inquiry card

6800/6809 I/O Boards by Gimix

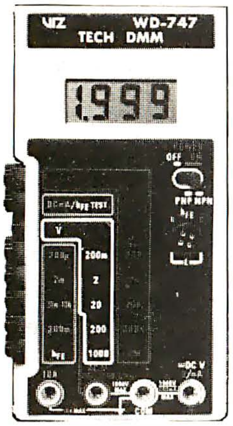
The Gimix 2-port serial I/O board has two independent RS-232-compatible I/O ports, with handshaking, on a 30-pin board. It features programmable pinouts and independent data rate and interrupt jumpers for each port. The board is compatible with the SS-50 and SS-50C bus configurations. The 2-port board, less cables, is priced at $128.43.

Also available is an 8-port serial I/O board that boasts eight independent RS-232-compatible I/O ports with handshaking—all on a 50-pin board. It features DIP-switch selectable data rates for each port, extended address decoding for the SS-50C bus, and selectable interrupts. An on-board data-rate generator permits rates of up to 38.4 k bps. This board costs $318.46, less cables. Complete details are available from Gimix Inc, 1337 W 37th Pl, Chicago IL 60609, (312) 927-5510.

Circle 454 on inquiry card

Circle 250 on inquiry card.

VIZ LCD Digital Multimeter

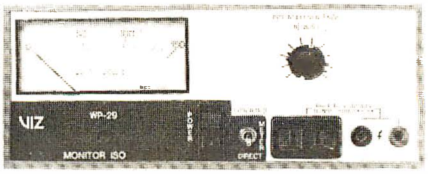


Model WD-747

- Large 3½ digit 0.5″ LCD readout.
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Power Supplies

WP-29 Monitor Isotap



• Supply line: 105 to 130V, 48 to 500Hz • Isolated output: 0 to 150V 48 to 500Hz • Leakage: Less than 0.1mA • Power rating (resistive load): 400VA • Meter: Taut band 3½″ ±2% • Size: 3⅜″ x 8¼″ x 8⅜″ • Weight: 14½ lb. • Comes with output cable.

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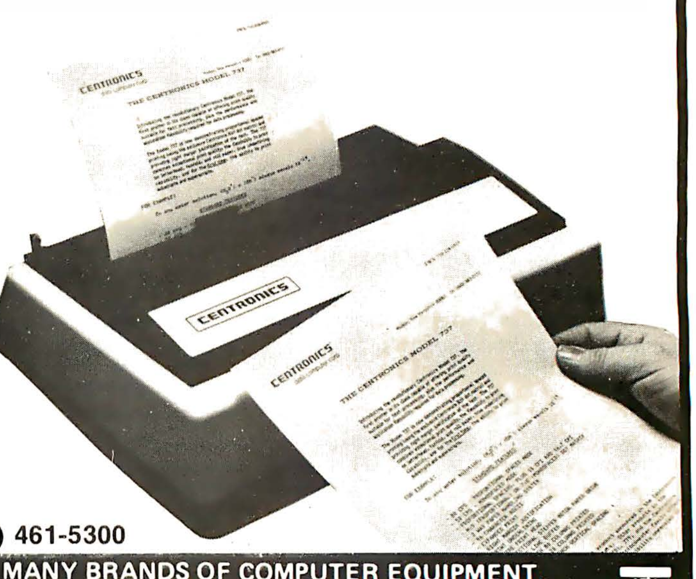
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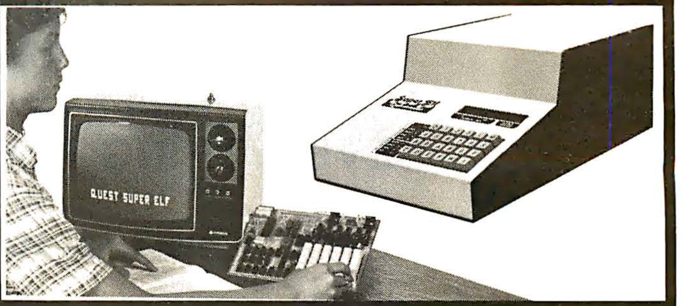
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Circle 251 on inquiry card.

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7493N	43
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74366N	75
74367N	75

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18	27	36	58
20	29	40	57

2 level 14 pin ww 20

WIRE WRAP LEVEL 3

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Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest** address and data bus displays **before, during** and **after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, input, memory protect, monitor select** and **single step.** Large, on board displays provide output and optional **high and low address**. There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockets for **all** IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. including a series of lessons to help get you started and a music program and graphics target game. Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and R&D.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95.** All metal Expansion Cabinet, painted and silk screened, with room for 5 S-100 boards and power supply **$57.00. NiCad Battery Memory Saver Kit $6.95.** All kits and options also completely assembled and tested.

Questdata, a software publication for 1802 computer users is available by subscription for $12.00 per 12 issues. Single issues $1.50. Issues 1-12 bound $16.50.

Tiny Basic Cassette **$10.00,** on ROM **$38.00,** original Elf kit board **$14.95. 1802 software;** Moews Video Graphics **$3.50.** Games and Music **$3.00,** Chip 8 Interpreter **$5.50.**

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface.** Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf.** The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed.** EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/ editor and error checking multi file cassette read/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports** with **full handshake.** They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50.** A **50 pin connector set** with ribbon cable is available at $15.25 for easy connection between the **Super Elf** and the **Super Expansion Board.**

Power Supply Kit for the complete system (see Multi-volt Power Supply).

Quest Super Basic V5.0

A new enhanced version of **Super Basic** now available. Quest was the first company worldwide to ship a full size Basic for 1802 Systems. A complete function **Super Basic** by **Ron Cenker** including floating point capability with scientific notation (number range ±.17E[38]), 32 bit integer ±2 billion; multi dim arrays, string arrays; string manipulation; cassette I/O; save and load, basic, data and machine language programs; and over 75 statements, functions and operations.

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Super Basic on Cassette $55.00.

Gremlin Color Video Kit $69.95

32 x 16 alpha/numerics and graphics; up to 8 colors with 6847 chip; 1K RAM at E000. Plugs into Super Elf 44 pin bus. No high res. graphics. On board RF Modulator Kit **$4.95**

Elf II Adapter Kit $24.95

Plugs into Elf II providing Super Elf 44 and 50 pin plus S-100 bus expansion. (With Super Expansion). High and low address displays, state and mode LED's optional **$18.00.**

1802 16K Dynamic RAM Kit $149.00

Expandable to 32K. Hidden refresh w/clocks up to 4 MHz w/no wait states. Addl. 16K RAM **$63.00**

Super Elf 44 pin expansion board; 3 female and 1 male bus. Board plus 3 connectors **$22.95**

Tiny Basic Extended on Cassette $15.00
(added commands include Stringy, Array, Cassette I/O etc.)

S-100 4-Slot Expansion $ 9.95
Super Monitor VI.I Source Listing $15.00

Super Color S-100 Video Kit $129.95

Expandable to 256 x 192 high resolution color graphics. 6847 with all display modes computer controlled. Memory mapped. 1K RAM expandable to 6K. S-100 bus 1802, 8080, 8085, Z80 etc.

Editor Assembler $25.00
(Requires minimum of 4K for E/A plus user source)

1802 Tiny Basic Source listing $19.00
Super Monitor V2.0/2.1 Source Listing $20.00

PROM Eraser

assembled. 25 PROM capacity **$37.50** (with timer **$69.50**). 6 PROM capacity OSHA/ UL version **$69.50** (with timer **$94.50**).

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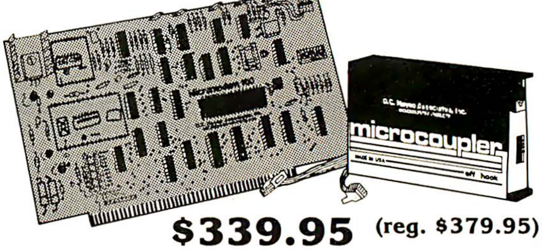
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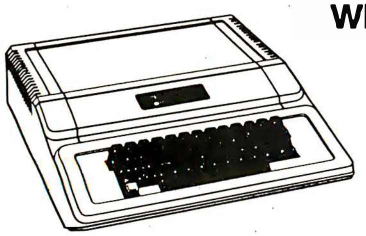
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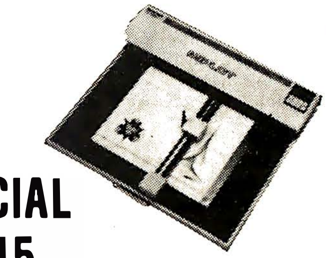
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10550	40/80 S/T PET	.140	5.80	5.25	4.65
10585	43/86 S/E COS/ELF	.140	6.95	6.25	5.55
10605	43/66 S/T COS/ELF	.140	6.60	5.95	5.30
10595	43/86 W/W COS/ELF	.200	6.90	6.20	5.95
10615	43/66 S/T COS/ELF	.200	6.80	8.10	5.40

.156" CONTACT CENTER CONNECTORS.

PART #	DESCRIPTION.	Row Sp.	1-9pc.	10-24pcs.	25pcs. Up.
15105	6/12 S/E PET/NSC	.140	$1.80	$1.65	$1.45
15110	6/12 S/T PET/NSC	.140	1.85	1.65	1.50
15137	6/12 S/T PET/NSC	.200	1.80	1.54	1.45
15175	6/- S/E Sgle Row	- -	1.70	1.50	1.30
15270	10/20 S/E	.140	2.15	1.95	1.70
15275	10/20 S/T	.140	2.00	1.85	1.60
15435	12/24 S/E PET	.140	2.60	2.35	2.10
15440	12/24 S/T PET	.140	2.65	2.40	2.15
15445	12/24 S/T PET	.200	2.75	2.50	2.20
15505	15/30 S/E GRI Key	.140	2.50	2.25	2.00
15510	15/30 S/T GRI Key	.140	2.40	2.15	2.95
15515	15/30 W/W GRI Key	.200	2.60	2.35	2.10
15600	18/36 S/E	.140	3.35	3.05	2.70
15610	18/36 S/T	.140	3.00	2.70	2.40
15815	18/36 W/W	.200	3.60	3.20	2.90
15700	22/44 S/E KIM/VEC	.140	2.98	2.90	2.75
15705	22/44 S/T KIM/VEC	.140	3.98	3.30	3.00
15710	22/44 W/W KIM/VEC	.200	3.49	3.20	2.85
15875	25/50 S/E	.140	4.65	4.20	3.75
15860	25/50 S/T	.140	4.55	4.10	3.65
15865	25/50 W/W	.200	4.85	4.35	3.90
16115	36/72 S/E	.140	6.50	5.85	5.20
16120	36/72 S/T	.140	6.55	5.90	5.25
16125	36/72 W/W	.200	6.75	6.10	5.40
16145	36/72 S/T	.200	6.50	5.85	5.20
16235	43/66 S/T Mot 6800	.140	6.60	5.95	5.30
16240	43/66 W/W Mot 6800	.200	7.80	7.05	6.25
16260	43/66 S/T Mot 6800	.200	6.50	5.65	5.20
16725	43/86 S/E Mot 6800	.140	7.20	6.50	5.75
K-1	Pol-Keys		.15	.12	.10

'D' TYPE SUBMINIATURE CONNECTORS.

PART NUMBER		DESCRIPTION.	QUANTITY 1-9pcs.	10-24pcs.	25-99pcs.
DE	9P	Male	$1.60ea.	$1.40ea.	$1.30ea.
DE	9S	Female	2.25ea.	2.00ea.	1.90ea.
DE	110963-1	2 pc. Grey Hood.	1.50ea.	1.35ea.	1.20ea.
DA	15P	Male	2.35ea.	2.15ea.	2.00ea.
DA	15S	Female	3.25ea.	3.10ea.	2.90ea.
DA	51211-1	1. pc. Grey Hood	1.40ea.	1.20ea.	1.15ea.
OA	51226-1	2 pc. Black Hood	2.50ea.	2.25ea.	2.00ea.
OA	110963-2	2 pc. Grey Hood	1.60ea.	1.35ea.	1.30ea.
DB	25P	Male	2.80ea.	2.80ea.	2.40ea.
DB	25S	Female	3.60ea.	3.40ea.	3.20ea.
OB	51212-1	1 pc. Grey Hood	1.50ea.	1.30ea.	1.10ea.
DB	51226-1	2 pc. Black Hood	1.90ea.	1.65ea.	1.45ea.
OB	110963-3	2 pc. Grey Hood	1.75ea.	1.50ea.	1.35ea.
DC	37P	Male	4.20ea.	4.00ea.	3.70ea.
DC	37S	Female	6.00ea.	5.75ea.	5.50ea.
DC	110963-4	2 pc. Grey Hood	2.25ea.	2.00ea.	1.75ea.
DO	50P	Male	5.50ea.	5.10ea.	4.75ea.
DO	50S	Female	9.40ea.	8.60ea.	8.00ea.
DO	51218-1	1 pc. Grey Hood	2.40ea.	2.20ea.	2. 00ea.
DD	110963-5	2 pc. Grey Hood	2.60ea.	2.40ea.	2.10ea.
D	20418-2	Hardware Set (1 Hood Set)	.90ea.	.80ea.	.70ea.

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14 pin $0.48 ea.
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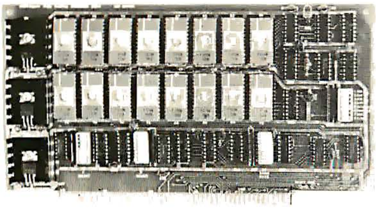
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USES 2716's

Blank PC Board - $34

ASSEMBLED & TESTED
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SPECIAL: 2716 EPROM's (450 NS) Are $11.95 EA. With Above Kit.

KIT FEATURES:
1. Uses +5V only 2716 (2Kx8) EPROM's.
2. Allows up to 32K of software on line!
3. IEEE S-100 Compatible.
4. Addressable as two independent 16K blocks.
5. Cromemco extended or Northstar bank select.
6. On board wait state circuitry if needed.
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8. Double sided PC board, solder-masked, silk-screened.
9. Gold plated contact fingers.
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11. Fully buffered and bypassed.
12. Easy and quick to assemble.

32K SS-50 RAM

$379.00 KIT

For 2MHZ
Add $10

Blank PC Board
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For SWTPC
6800 - 6809 Buss

Support IC's
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$19.95

Complete Socket Set
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Tested, Burned In
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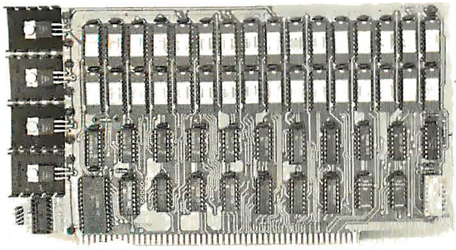
FEATURES:
1. Uses proven low power 2114 Static RAMS.
2. Supports SS50C - EXTENDED ADDRESSING.
3. All parts and sockets included.
4. Dip Switch address select as a 32K block.
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16K STATIC RAM KIT-S 100 BUSS

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$199.95 KIT

FOR 4MHZ
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9. LOW POWER: under 1.5 amps TYPICAL from the +8 Volt Buss.
10. Blank PC Board can be populated as any multiple of 4K.

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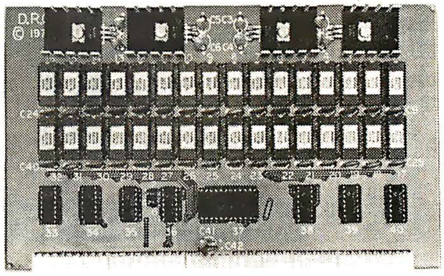
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At last, an S-100 Board that unleashes the full power of two unbelievable General Instruments AY3-8910 NMOS computer sound IC's. Allows you under total computer control to generate an infinite number of special sound effects for games or any other program. Sounds can be called in BASIC, ASSEMBLY LANGUAGE, etc.

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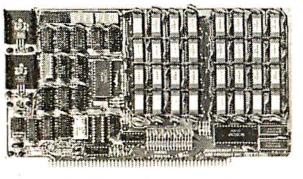
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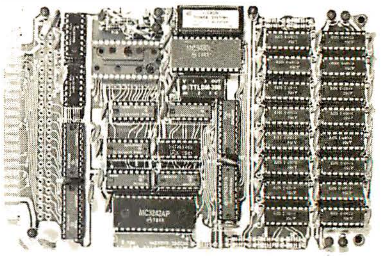
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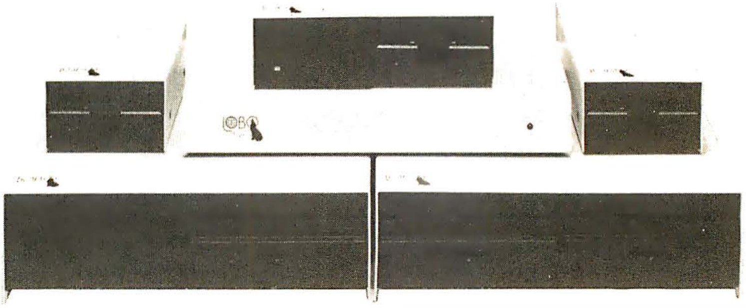
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8212C	Two SA801 in cabinet w/power
5212	Two SA851 in cabinet
5212C	Two SA851 in cabinet w/power

TRS80

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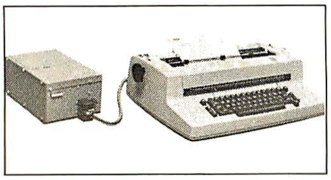
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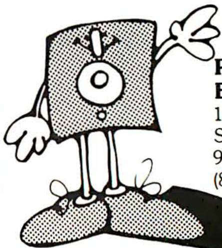
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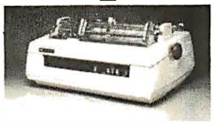
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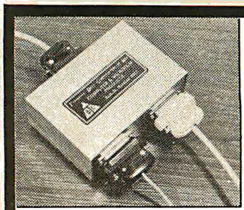
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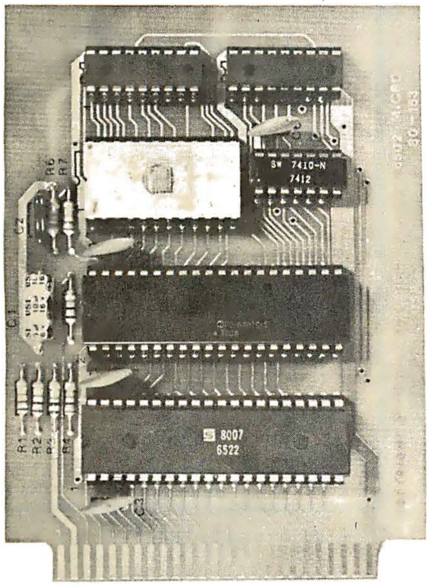
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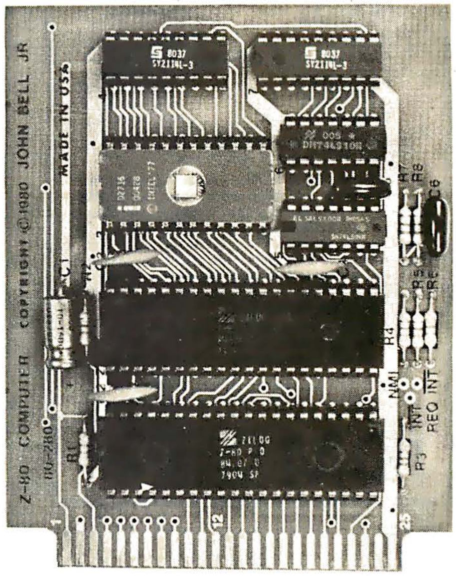
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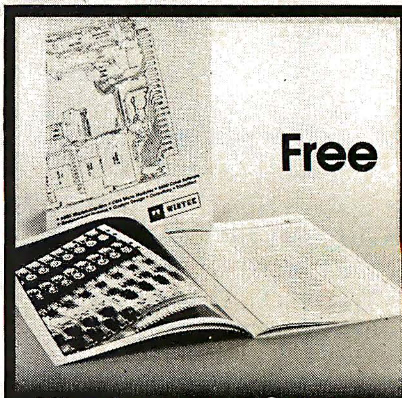
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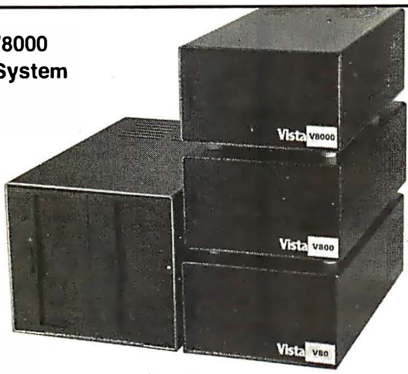
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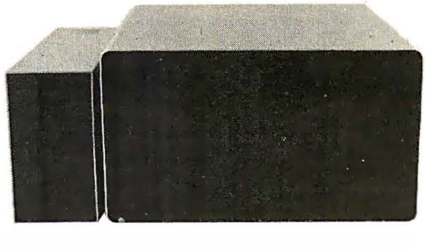
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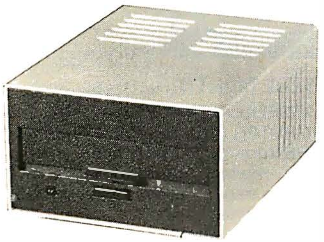


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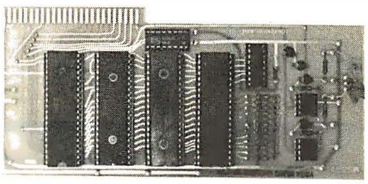
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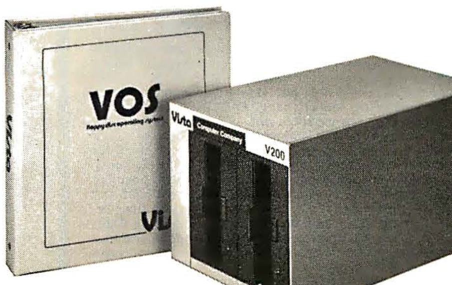
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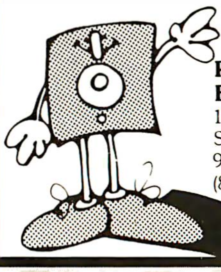
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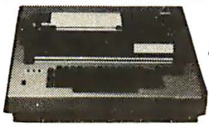
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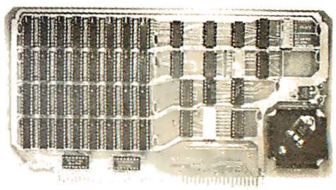
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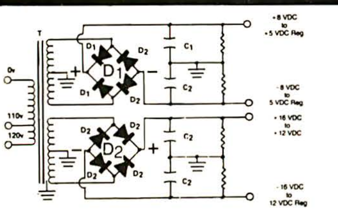
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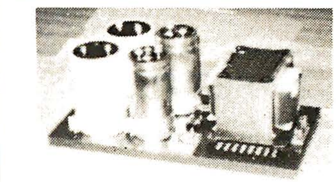
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SHUGART floppy disk drives sgl sided, dbl density.

SHU-801R	$ 395.00
Special Sale Price	2 for $775.00

Qume Datatrak 8" dbl sided, dbl density

QME-8DS (851R compatible)	$ 599.00
Pkg of two	$ 549.00 ea.

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MPI-B51 MPI B-51 Sgl Sided, Sgl/Dbl Den Exact Replacement for SA-400	$ 235.00
MPI-B52 MPI B-52 Dbl Sided, Dbl Den	$ 350.00
MPI-B91 MPI B-91 Sgl Sided, Dbl Den, 77 Tracks	$ 395.00

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6 Slot (5¼" x 8¾")

QTC-6 Slot BB Bare board	$19.95
QTC-6 Slot K kit	$39.95
QTC-6 Slot AT A&T	$49.95

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QTC-12 Slot BB Bare board	$29.95
QTC-12 Slot K kit	$69.95
QTC-12 Slot AT A&T	$89.95

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QTC-18 Slot BB Bare board	$ 49.95
QTC-18 Slot K kit	$ 99.95
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MEX-16A2 Apple kit	$32.00

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5¼" disk drive with controller for your Apple

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Parallel & serial interface for your Apple

SSM-AIO K Kit	$159.00
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APPLE CLOCK - QT System

Real time clock w/battery back-up

QTC-CCA-AT A&T	$125.00

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Speech recognition/synthesizer w/speaker & mike

MHW-STLK A&T	$275.00

Z-80 CARD for APPLE (MICRO-SOFT)

Z-80 CPU card with CP/M for your Apple

MST-Z80 A&T	$289.00

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Auto answer/dial modem card for Apple or S-100

DCH-MM2 Apple modem	$349.95
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16 PIN ZIP* DIP II	$ 5.50
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BARE BOARDS AVAILABLE ON MANY PRODUCTS

S-100 PRODUCTS

WE ACCEPT M/C VISA & AM EXP

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5¼" or 8" disk controller with free CP/M 2.2

CCS-2422A A&T	$374.95

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2.5 MHz Z80 CPU with serial & parallel I/O ports

SDS-SBC100K Kit	$318.00
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SDS-SBC200AT A&T	$408.00

CB2 - S.S.M.

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SSM-CB2K Kit	$239.95
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2 or 4 MHz Z80A CPU w/serial I/O port

CCS-2810 A&T	$275.00

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2.5 MHz RAM board expandable from 16K to 64K

SDS-RAM16K 16K kit	$269.95
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SDS-RAM32K 32K kit	$309.95
SDS-RAM32AT 32K A&T	$359.95
SDS-RAM48K 48K kit	$349.95
SDS-RAM48AT 48K A&T	$399.95
SDS-RAM64K 64K kit	$389.95
SDS-RAM64AT 64K A&T	$439.95

S-100 Extender - Cal Comp Sys

Puts problem boards within easy reach

CCS-2520A A&T	$ 24.95

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4 MHz RAM board expandable from 16K to 256K

SDS-RAM216K 16K kit	$289.95
SDS-RAM216AT 16K A&T	$339.95
SDS-RAM232K 32K kit	$329.95
SDS-RAM232AT 32K A&T	$379.95
SDS-RAM248K 48K kit	$369.95
SDS-RAM248AT 48K A&T	$419.95
SDS-RAM264K 64K kit	$409.95
SDS-RAM264AT 64K A&T	$459.95

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CCS-2016B 16K 2 MHz A&T	$279.00
CCS-2016BCK 16K 4 MHz A&T	$309.00

PB-1 - S.S.M.

2708, 2716 EPROM board with built-in programmer

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SSM-PB1AT A&T	$239.95

PROM-100 - SD Systems

2708, 2716, 2732, 2758 & 2516 EPROM programmer

SDS-PROM-100K kit	$220.00
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I/O-4 - S.S.M.

2 serial I/O ports plus 2 parallel I/O ports

SSM-IO4K kit	$179.95
SSM-IO4AT A&T	$259.95
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Versafloppy II - SD Systems

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80 x 24 I/O mapped video board with keyboard I/O

SDS-VDBK kit	$406.00
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80 x 24 x 48 memory mapped with graphics

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Z-80 computer with RAM, ROM, I/O & keyboard

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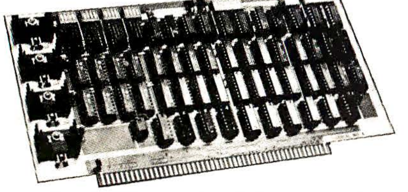
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MEM-64565A *A & T* $449.95

Memory Bank - Jade
4 MHz, IEEE S-100, bank selectable, 8 or 16 bit
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MEM-16730K *16K kit* $249.95
MEM-16730A *16K A & T* $299.95
MEM-32731K *32K kit* $289.95
MEM-32731A *32K A & T* $339.95
MEM-48732K *48K kit* $324.95
MEM-48732A *48K A & T* $374.95
MEM-64733K *64K kit* $359.95
MEM-64733A *64K A & T* $409.95
MEM-99730B *Bare board* $55.00

ExpandoRAM II - SD Systems
4 MHz RAM board expandable from 16K to 256K
MEM-16630K *16K kit* $289.95
MEM-16630A *16K Jade A & T* $339.95
MEM-32631K *32K kit* $329.95
MEM-32631A *32K Jade A & T* $379.95
MEM-48632K *48K kit* $369.95
MEM-48631A *48K Jade A & T* $419.95
MEM-64633K *64K kit* $409.95
MEM-64633A *64K Jade A & T* $459.95

32K STATIC RAM - Jade
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MEM-32151A *32K 4 MHz A & T* ... $349.95

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MEM-16160B *Bare board* $29.95

THE BIG Z* - Jade
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CPU-30200B *Bare board* $35.00

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CPC-30100A *Jade A & T* $369.95

SBC-200 - SD Systems
4 MHz Z-80 CPU with serial & parallel I/O ports*
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CPC-30200A *Jade A & T* $399.95

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2 or 4 MHz switchable Z-80 CPU with RAM, ROM, & I/O*
CPU-30300K *Kit* $239.95
CPC-30300A *A & T* $299.95

2810 Z-80* CPU - Cal Comp Sys
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CPU-30400A *A & T* $275.00

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Double density controller with the inside track
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IOD-1200A *8" A & T* $389.95
IOD-1205A *5¼" A & T* $389.95
IOD-1200B *Bare board* $65.00

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IOD-1300A *A & T* $374.95

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Our new I/O card with 2 SIO's, 4 CTC's, and 1 PIO
IOI-1045K *2 CTC's, 1 SIO, 1 PIO* .. $199.00
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IOI-1046K *4 CTC's, 2 SIO's, 1 PIO* $259.00
IOI-1046A *A & T* $319.00
IOI-1045B *Bare board w/ manual* ... $59.95
IOI-1045D *Manual only* $20.00

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2 serial I/O ports plus 2 parallel I/O ports
IOI-1010K *Kit* $179.95
IOI-1010A *A & T* $259.95
IOI-1010B *Bare board* $35.00

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Crystal controlled S-100 clock with NiCad backup
IOK-1400A *A & T* $329.95

SB1 - S.S.M.
15 Hz to 25K Hz music synthesizer for S-100
IOS-1005K *Kit* $239.95
IOS-1005A *A & T* $299.95

TB-4 - Mullen
Extremely versatile extender board with logic probe
TSX-180K *Kit* $55.00
TSX-180A *A & T* $75.00

S-100 EXTENDER - Cal Comp Sys
Puts problem boards within easy reach
TSX-160A *A & T* $24.95

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64 x 16 assembled & tested S-100 video board
IOV-1050B *Bare board* $25.00
IOV-1050K *Kit* $99.95
IOV-1050A *A & T sale price* $139.95

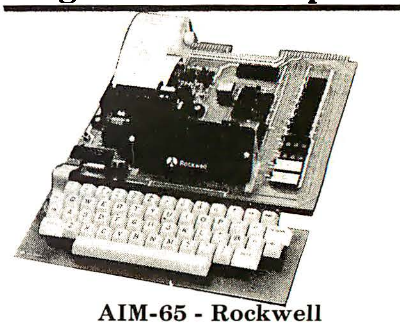
VDB-8024 - SD Systems
80 x 24 I/O mapped video board with keyboard I/O
IOV-1020K *Kit* $399.95
IOV-1020A *Jade A & T* $459.95

VB3 - S.S.M.
80 x 24 or 80 x 48 memory mapped with graphics
IOV-1095K *Kit, 4 MHz* $399.95
IOV-1095A *A & T, 4 MHz* $464.95
IOV-1096K *80 x 48 upgrade, 4 MHz* . $89.00

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MEM-99510K *Kit* $159.95
MEM-99510A *A & T* $239.95

PROM-100 - SD Systems
2708, 2716, 2732, 2758, & 2516 EPROM programmer
MEM-99520K *Kit* $219.95
MEM-99520A *Jade A & T* $269.95

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6502 computer with printer, display, & keyboard
CPK-50165 *1K AIM* $374.95
CPK-50465 *4K AIM* $449.95
SFK-74600008E *8K BASIC ROM* $99.95
SFK-64600004E *4K assembler ROM* $84.95
PSX-030A *Power supply* $64.95
ENX-000002 *Enclosure* $49.95
4K AIM, 8K BASIC, power supply, & enclosure
Special package price $625.00

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CPS-30010A *Jade A & T* $459.95

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Silent, simple, and on sale - a better motherboard
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MBS-061K *Kit* $39.95
MBS-061A *A & T* $49.95
12 Slot (9¼" x 8⅝")
MBS-121B *Bare board* $29.95
MBS-121K *Kit* $69.95
MBS-121A *A & T* $89.95
18 Slot (14½" x 8⅝")
MBS-181B *Bare board* $49.95
MBS-181K *Kit* $99.95
MBS-181A *A & T* $139.95

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MAINFRAME - Cal Comp Sys
12 slot S-100 mainframe with 20 amp power supply
ENC-112105 *Kit* $309.95
ENC-112106 *A & T* $349.95

DISK MAINFRAME - NNC
Dual 8" drive cutouts with 8 slot motherboard
ENS-112320 *with 30 amp p.s.* $699.95

Video Monitors

9" B & W MONITOR - A.P.F.
High quality, high resolution video monitor
VDM-750900 *9" monitor* $149.95

13" COLOR MONITOR - Zenith
The hi res color you've been promising yourself
VDC-201301 .... $449.00

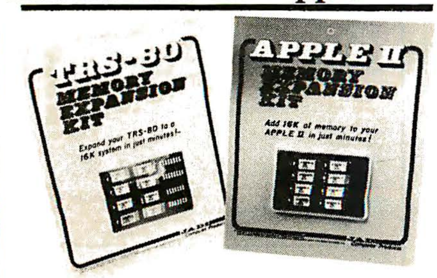
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MEX-16100K *TRS-80 kit* **$39.95**
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5¼" disk drive with controller for your Apple
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PRINTER INTERFACE - Cal Comp Sys
Centronics type I/O card w/ firmware
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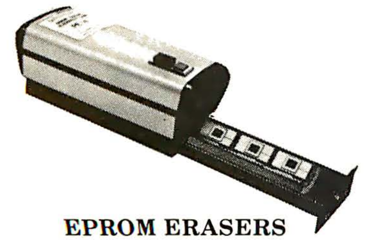
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Real time clock w/battery back-up
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Speech recognition/synthesizer w/speaker & mike
IOS-2015A *A & T* **$275.00**

Z-80* CARD for APPLE
Z-80 CPU card with CP/M for your Apple*
CPX-30800A *A & T* **$279.95**

MICROMODEM - D.C. Hayes
Auto answer/dial modem card for Apple or S-100
IOM-2010A *Apple modem* **$349.95**
IOM-1100A *S-100 modem* **$375.00**

Micronet Modem - Micromate
Direct connect modem with extra features
IOM-2020A *Best Apple modem* **$275.00**



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Spectronics hi intensity industrial eraser
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8" Disk Drive Sale



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MSF-201120 *6 mo warranty* **$395.00**
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Qume Datatrak 8 double sided, double density
MSF-750080 *SA-851R compatible* .. **$625.00**
Special sale price .... ***2 for $1198.00***

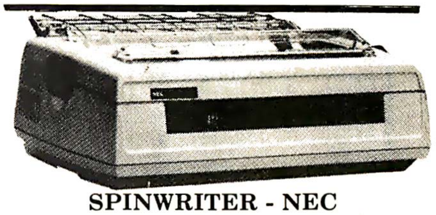
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MMD-8110103 *Soft sector* **$33.95**
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MMD-8220103 *Soft sector* **$57.95**

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IOM-5200A *Special sale price* **$139.00**
D-CAT 300 baud, direct connect modem
IOM-5201A *Special sale price* **$179.00**

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6809	39.95
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8080A	6.59
8085	15.95
8748	59.95

Z-80 SUPPORT

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3881-4 *PIO 4 MHz*	14.50
3882 *CTC*	9.50
3882-4 *CTC 4 MHz*	14.95
3883 *SIO*	29.50
3884 *SIO*	49.50

6800 SUPPORT

6821P	5.95
6828P	11.95
6834P	22.50
6840P	18.75
6850P	4.80
6852P	5.79
6875L	7.40
68488P	25.00

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MC14411	10.00
1.843 MHz xtal	4.95

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AY3-1014A	8.25
TR1602B	5.25
TMS6011	5.95
IM6402	9.00

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2708 *450ns*	8.25
10 for $59.00	
2716 *12,5v*	12.95
2716 *5v*	12.95
10 for $99.00	
2532 *5v*	39.95
2732 *5v*	39.95
2758 *5v*	19.95

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SN7401N	.20
SN7402N	.25
SN7403N	.25
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SN7407N	.35
SN7408N	.29
SN7409N	.29
SN7410N	.25
SN7411N	.29
SN7412N	.35
SN7413N	.40
SN7414N	.69
SN7416N	.29
SN7417N	.29
SN7420N	.25
SN7421N	.29
SN7422N	.45
SN7423N	.29
SN7425N	.29
SN7426N	.29
SN7427N	.25
SN7429N	.39
SN7430N	.25
SN7432N	.29
SN7437N	.25
SN7438N	.40
SN7439N	.25
SN7440N	.20
SN7441N	.89
SN7442N	.59
SN7443N	1.10
SN7444N	1.10
SN7445N	.89
SN7446N	.79
SN7447N	.69
SN7448N	.79
SN7450N	.20
SN7451N	.20
SN7453N	.20
SN7454N	.20
SN7459A	.25
SN7460N	.20
SN7470N	.29

SN7472N	.29
SN7473N	.35
SN7474N	.35
SN7475N	.49
SN7476N	.35
SN7479N	5.00
SN7480N	.50
SN7482N	.99
SN7483N	.69
SN7485N	.89
SN7486N	.35
SN7489N	1.75
SN7490N	.49
SN7491N	.59
SN7492N	.45
SN7493N	.45
SN7494N	.69
SN7495N	.69
SN7496N	.69
SN7497N	3.00
SN74100N	1.49
SN74107N	.35
SN74109N	.39
SN74116N	1.95
SN74121N	.39
SN74122N	.55
SN74123N	.59
SN74125N	.49
SN74126N	.49
SN74132N	.75
SN74136N	.75
SN74141N	.99
SN74142N	3.25
SN74143N	3.49
SN74144N	3.49
SN74145N	.79
SN74147N	1.95
SN74148N	1.29
SN74150N	1.25
SN74151N	.69
SN74152N	.69
SN74153N	.79
SN74154N	1.25
SN74155N	.79

SN74156N	.79
SN74157N	.69
SN74160N	.89
SN74161N	.89
SN74162N	.89
SN74163N	.89
SN74164N	.89
SN74165N	.89
SN74166N	1.25
SN74167N	2.79
SN74170N	1.95
SN74172N	4.95
SN74173N	1.39
SN74174N	.99
SN74175N	.89
SN74176N	.79
SN74177N	.79
SN74179N	1.49
SN74180N	.79
SN74181N	2.25
SN74182N	.79
SN74184N	2.49
SN74185N	2.49
SN74190N	1.25
SN74191N	1.25
SN74192N	.89
SN74193N	.89
SN74194N	.89
SN74195N	.69
SN74196N	.89
SN74197N	.89
SN74198N	1.49
SN74199N	1.49
SN74221N	1.25
SN74251N	.99
SN74276N	1.95
SN74279N	.79
SN74283N	1.49
SN74284N	3.95
SN74285N	3.95
SN74365N	.69
SN74366N	.69
SN74367N	.69
SN74368N	.69
SN74390N	1.49
SN74393N	1.49

74LS

74LS00	.29
74LS01	.29
74LS02	.29
74LS03	.29
74LS04	.35
74LS05	.35
74LS08	.29
74LS09	.35
74LS10	.29
74LS11	.75
74LS12	.35
74LS13	.59
74LS14	.99
74LS15	.35
74LS20	.29
74LS21	.35
74LS22	.35
74LS26	.35
74LS27	.35
74LS28	.35
74LS30	.29
74LS32	.35
74LS33	.59
74LS37	.45
74LS38	.49
74LS40	.35
74LS42	.89
74LS47	.89
74LS48	1.15
74LS49	1.15
74LS51	.29
74LS54	.29
74LS55	.29
74LS73	.45
74LS74	.45
74LS75	.59
74LS76	.45
74LS78	.49
74LS83	.89
74LS85	1.25
74LS86	.45
74LS90	.59

74LS92	.75
74LS93	.75
74LS95	.99
74LS96	1.15
74LS107	.45
74LS109	.45
74LS112	.45
74LS113	.49
74LS114	.49
74LS122	.89
74LS123	1.25
74LS125	.89
74LS126	.55
74LS132	.99
74LS133	.89
74LS136	.49
74LS138	.89
74LS139	.89
74LS151	.89
74LS153	.89
74LS154	1.75
74LS155	1.19
74LS156	1.19
74LS157	.89
74LS158	.99
74LS160	1.15
74LS161	1.15
74LS162	1.15
74LS163	1.15
74LS164	1.25
74LS165	1.25
74LS168	1.19
74LS169	1.19
74LS170	2.49
74LS173	1.39
74LS174	.99
74LS175	.99
74LS181	2.95
74LS190	1.25
74LS191	1.25

74LS192	1.15
74LS193	1.15
74LS194	1.15
74LS195	1.15
74LS197	1.19
74LS221	1.19
74LS240	1.95
74LS241	1.95
74LS242	1.95
74LS243	1.95
74LS244	1.95
74LS245	2.95
74LS247	1.19
74LS248	1.19
74LS249	1.19
74LS251	1.49
74LS253	.99
74LS257	.89
74LS258	.99
74LS260	.69
74LS266	.69
74LS273	1.95
74LS279	.75
74LS283	1.09
74LS290	.99
74LS293	.99
74LS298	1.25
74LS352	1.29
74LS353	1.29
74LS365	.75
74LS366	.75
74LS367	.75
74LS368	.75
74LS373	1.95
74LS374	1.95
74LS375	.89
74LS386	.69
74LS393	2.49
74LS399	2.49
74LS670	2.49
81LS95	1.95
81LS97	1.95

74S

74S00	.50
74S02	.50
74S03	.50
74S04	.55
74S05	.55
74S08	.50
74S09	.50
74S10	.50
74S11	.50
74S15	.50
74S20	.50
74S22	.50
74S30	.50
74S32	.55
74S40	.55
74S51	.50
74S64	.50
74S65	.50
74S74	.79
74S86	.79
74S112	.79
74S113	.79
74S114	.79

74S133	.55
74S134	.69
74S135	1.19
74S136	1.75
74S138	1.35
74S139	1.35
74S140	1.15
74S151	1.35
74S153	1.35
74S157	1.35
74S158	1.35
74S174	1.59
74S175	1.59
74S188	4.95
74S194	1.95
74S195	1.95
74S196	3.95
74S240	2.95
74S241	2.95
74S242	3.25
74S243	3.25

74S244	3.25
74S251	1.45
74S253	1.45
74S257	1.35
74S258	1.35
74S260	.79
74S280	2.95
74S287*	4.95
74S288*	4.95
74S373	3.49
74S374	3.49
74S387*	5.95
74S471*	19.95
74S472*	19.95
74S473*	19.95
74S474*	21.95
74S475*	21.95
74S570*	7.95
74S571*	7.95
74S572*	19.95
74S573*	19.95
74S940	3.15
74S941	3.15

* LIMITED AVAILABILITY ON THESE PROMS

CA–LINEAR

CA3013H	2.15
CA3023H	3.25
CA3039H	1.35
CA3046N	1.30
CA3059N	3.25
CA3060N	3.25
CA3080H	1.25
CA3081N	2.00
CA3082N	2.00
CA3083N	1.60
CA3086N	.85
CA3089N	3.75
CA3096N	3.95
CA3130H	1.39
CA3140H	1.25
CA3160H	1.25
CA3401N	.59
CA3600N	3.50

CD–CMOS

CD4000	.39
CD4001	.39
CD4002	.39
CD4006	1.19
CD4007	.25
CD4009	.49
CD4010	.49
CD4011	.39
CD4012	.25
CD4013	.49
CD4014	1.39
CD4015	1.19
CD4016	.59
CD4017	1.19
CD4018	.99
CD4019	.49
CD4020	1.19
CD4021	1.39
CD4022	1.19
CD4023	.29
CD4024	.79
CD4025	.23
CD4026	2.95
CD4027	.69
CD4028	.89
CD4029	1.49
CD4030	.49
CD4035	.99
CD4040	1.49

CD4041	1.49
CD4042	.99
CD4043	.89
CD4044	.89
CD4046	1.79
CD4047	2.50
CD4048	1.35
CD4049	.49
CD4050	.69
CD4051	1.19
CD4052	1.19
CD4053	1.19
CD4056	2.95
CD4059	9.95
CD4060	1.49
CD4066	.79
CD4068	.39
CD4069	.45
CD4070	.55
CD4071	.49
CD4072	.49
CD4073	.39
CD4075	.39
CD4076	1.39
CD4081	.39

CD4082	.39
CD4093	.99
CD4098	2.49
CD4506	.75
CD4507	.99
CD4508	3.95
CD4510	1.39
CD4511	1.29
CD4514	3.95
CD4515	2.95
CD4516	1.49
CD4518	1.79
CD4519	.89
CD4520	1.29
CD4526	1.79
CD4528	1.79
CD4529	1.95
CD4543	2.79
CD4562	11.95
CD4566	2.79
CD4583	2.49
CD4723	1.95
CD4724	1.95
MC14409	14.95
MC14410	14.95
MC14411	14.95
MC14412	11.95
MC14419	4.95
MC14433	13.95

LITRONIX DISPLAY SALE

LIMITED OFFER!! — WHILE THEY LAST!!



MULTI-DIGIT REFLECTOR ARRAYS FOR CLOCKS

PART NUMBER	CHAR. HT. (IN.)	POLARITY	DESCRIPTION	LIGHT OUTPUT (MCD) TYP	MIN	@mA	FORWARD VOLTAGE SEGMENT (V) I_F = 20mA TYP	MAX	CONTINUOUS FORWARD CURRENT PER SEGMENT (mA) MAX	PRICE
DL-4500 (Red)	.50	C.C. MPX	4 Digit 7 Segment With Colon And Auxiliary Indicators	.8	.5	10	1.7	2.0	30	2.49
DL-4507 (Red)		C.C. MPX		--	1.0					2.49
DLO-4507 (orng)		C.C. non MPX		.8	.5					4.95
DLG-4507 (grn)		C.C. non MPX								4.95
DL-4520A (red)		C.C. non MPX								2.49
DL-4120A (red)	1.0	C.C. non MPX		1.5	.9		3.4	4.0		4.95

MULTI-DIGIT REFLECTOR ARRAYS

DL 2300 (Red)	.30	C.C. MPX	7 Seg. 2 Digit D.P. Right	2.5	1.1	20	1.7	2.0	30	.99
DLG 2535 (green)	.50	C.A. MPX	9 Seg. 2 Digit		2.5	20		3.5	25	1.49
DL-4509 (Red)	.50	C.C. MPX	9 Seg. 4 Digit D.P. Right	.8	.5	10	1.7	2.0	30	2.49
DL 6500 (Red)	.50	C.C. MPX	7 Seg. 6 Digit D.P. Right	.8	.5	10	1.7	2.0	30	2.95
DL-6530 (Red)	.50	C.A. MPX	7 Seg. 6 Digit D.P. Right	.8	.5	10	1.7	2.0	30	2.95
DL-3130 (Red)	1.0	C.A. MPX	7 Seg. 3 Digit D.P. Right	1.5	1.0	10	3.4	4.0	30	3.95

DISCRETE LEDS

XC556R	.200"	red	5/$1
XC556G	.200"	green	4/$1
XC556Y	.200"	yellow	4/$1
XC556C	.200"	clear	4/$1
XC22R	.200"	red	5/$1
XC22G	.200"	green	4/$1
XC22Y	.200"	yellow	4/$1
MV10B	.170"	red	4/$1
MV50	.085"	red	6/$1
XC209R	.125"	red	5/$1
XC209G	.125"	green	4/$1
XC209Y	.125"	yellow	4/$1
XC526R	.185"	red	5/$1
XC526G	.185"	green	4/$1
XC526Y	.185"	yellow	4/$1
XC526C	.185"	clear	4/$1
XC111R	.190"	red	5/$1
XC111G	.190"	green	4/$1
XC111Y	.190"	yellow	4/$1
XC111C	.190"	clear	4/$1

XC556 RED LED, METAL MTG. HDW. 2-6" LEADS.
RL-2 . . $.39 ea. or 3/$1.00

DISPLAY LEDS

C.A. — Common Anode — C.C. — Common Cathode

Type	Polarity	Ht	Price
MAN 1	C.A.—red	.270	2.95
MAN 2	5x7 D.M.—red	.300	4.95
MAN 3	C.C.—red	.125	.25
MAN 52	C.A.—green	.300	1.25
MAN 54	C.C.—green	.300	1.25
MAN 71	C.A.—red	.300	.75
MAN 72	C.A.—red	.300	.75
MAN 74	C.C.—red	.300	1.25
MAN 82	C.A.—yellow	.300	.49
MAN 84	C.C.—yellow	.300	.99
MAN 3620	C.A.—orange	.300	.49
MAN 3630	C.A.—orange ± 1	.300	.99
MAN 3640	C.C.—orange	.300	.99
MAN 4610	C.A.—orange	.400	.99
MAN 6610	C.A.—orange—DD	.560	.99
MAN 6630	C.A.—orange ± 1	.560	.99
MAN 6640	C.C.—orange—DD	.560	.99
MAN 6650	C.C.—orange ± 1	.560	.99
MAN 6660	C.A.—orange	.560	.99
MAN 6710	C.A.—red—DD	.560	.99
MAN 6750	C.C.—red ± 1	.560	.99
MAN 6780	C.C.—red	.560	.99
DLO304	C.C.—orange	.300	1.25
DLO307	C.A.—orange	.300	1.25
DLG500	C.C.—green	.500	1.25

Type	Polarity	Ht	Price
DLG507	C.A.—green	.500	1.25
DL704	C.C.—red	.300	1.25
DL707	C.A.—red	.300	1.25
DL728	C.C.—red	.500	1.49
DL741	C.A.—red	.600	1.25
DL746	C.A.—red ± 1	.630	1.49
DL747	C.A.—red	.600	1.49
DL750	C.C.—red	.600	1.49
DLO847	C.A.—orange	.800	1.49
DLO850	C.C.—orange	.800	1.49
DL33B	C.C.—red	.110	.35
FND358	C.C. ± 1	.357	.99
FND359	C.C.	.357	.75
FND503	C.C. (FND500)	.500	.99
FND507	C.A. (FND510)	.500	.99
HDSP-3401	C.A.—red	.800	1.50
HDSP-3403	C.C.—red	.800	1.50
5082-7751	C.A., R.H.D.—red	.430	1.25
5082-7760	C.C., R.H.D.—red	.430	1.75
5082-7300	4x7 sgl. dig. RHD	.600	22.00
5082-7302	4x7 sgl. dig. LHD	.600	22.00
5082-7304	Overnge. char. (±1)	.600	19.95
4N28	Photo Xsistor Opto-Isol.		.99
LIT-1	Photo Xsistor Opto-Isol.		.69
MOC3010	Optically Isol. Triac Driver		1.25

POTENTIOMETERS



$2.95 each
2 Watt @ 70°C ± 10%
7/8" Slotted Shaft
Linear Taper
Meets Mil-R-94

Part No.		
CMU 1021	RV4NAY SD - 102A	1K
CMU 5021	RV4NAY SD - 502A	5K
CMU 1031	RV4NAY SD - 103A	10K
CMU 2531	RV4NAY SD - 253A	25K
CMU 5031	RV4NAY SD - 503A	50K
CMU 1041	RV4NAY SD - 104A	100K
CMU 1052	RV4NAY SD - 105A	1Meg



$1.35 each
3/4 Watt @ 70°C
15 turn pot. Linear taper. Printed circuit mount.

Part No.	Part No.	Part No.
830P- 50ohm	830P- 5K	830P-100K
830P-100ohm	830P-10K	830P-200K
830P-500ohm	830P-20K	830P-500K
830P-1K	830P-50K	830P-1Meg
830P-2K		

LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5ea.	10 Ohm 27 Ohm	12 Ohm 33 Ohm	15 Ohm 39 Ohm	18 Ohm 47 Ohm	22 Ohm 56 Ohm	50pcs.	$1.95
ASST. 2	5ea.	68 Ohm 180 Ohm	82 Ohm 220 Ohm	100 Ohm 270 Ohm	120 Ohm 330 Ohm	150 Ohm 390 Ohm	50pcs.	$1.95
ASST. 3	5ea.	470 Ohm 1.2K	560 Ohm 1.5K	680 Ohm 1.8K	820 Ohm 2.2K	1K 2.7K	50pcs.	$1.95
ASST. 4	5ea.	3.3K 8.2K	3.9K 10K	4.7K 12K	5.6K 15K	6.8K 18K	50pcs.	$1.95
ASST. 5	5ea.	22K 56K	27K 68K	33K 82K	39K 100K	47K 120K	50pcs.	$1.95
ASST. 6	5ea.	150K 390K	180K 470K	220K 560K	270K 680K	330K 820K	50pcs.	$1.95
ASST. 7	5ea.	1M 2.7M	1.2M 3.3M	1.5M 3.9M	1.8M 4.7M	2.2M 5.6M	50pcs.	$1.95

ASST. 8R — Includes Resistor Assts. 1-7 (350 pcs.) — $10.95 ea.

$10.00 Min. Order – U.S. Funds Only
Calif. Residents Add 6% Sales Tax
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INTERSIL

Part No.	Function	Price
7045IPI	CMOS Precision Timer	14.95
7045EV/Kit*	Stopwatch Chip, XTL	22.95
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	28.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	9.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	11.10
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter	12.95
7218CIJI	8-Digit Univ. LED Drive	10.95
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
7240IJE	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8069CCQ	50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.50
8212CPA	Volt Ref/Indicator	2.50

* INTERSIL'S EVALUATION KITS

74C

74C00	.39
74C02	.39
74C04	.39
74C08	.39
74C10	.39
74C14	.75
74C20	.39
74C30	.39
74C42	1.39
74C48	1.95
74C73	.79
74C74	.79
74C85	1.95
74C86	.99
74C89	6.95
74C90	1.29
74C93	1.29
74C95	1.59

74C106	.75
74C107	1.89
74C151	2.95
74C154	3.95
74C157	2.25
74C160	1.69
74C161	1.60
74C162	1.49
74C163	1.69
74C164	1.59
74C173	1.39
74C174	1.39
74C175	1.39
74C192	1.69
74C193	1.69

74C195	1.59
74C221	1.95
74C240	2.25
74C244	2.25
74C373	2.49
74C374	2.59
74C901	.89
74C903	1.15
74C911	10.95
74C912	10.95
74C915	1.69
74C917	10.95
74C922	5.49
74C923	5.75
74C925	7.50
74C926	7.50
80C95	.79
80C97	.79

LINEAR

LH0002CN	6.85
LM10CLH	4.50
LM11CLH	4.75
LH0070-OH	6.05
TL071CP	.79
TL072CP	1.39
TL074CN	2.49
LH0082CD	35.80
TL082CP	1.19
TL084CN	2.19
LH0094CD	36.80
LM300H	.99
LM301CN	.35
LM302H	1.95
LM304H	1.95
LM305H	.99
LM307CN	.45
LM308CN	1.00
LM309H	1.95
LM309K	1.25
LM310CN	1.75
LM311H	.90
LM312H	2.49
LM317MP	1.15
LM317T	1.75
LM317K	3.95
LM318CN	1.95
LM319N	1.95
LM320K-5	1.35
LM320K-12	1.35
LM320K-15	1.35
LM320T-5	1.25
LM320T-12	1.25
LM320T-15	1.25
LM323K-5	5.95
LM324N	.99
LM329DZ	.65
LM331N	3.95
LM334Z	1.30
LM335Z	1.40
LM336Z	1.75
LM337T	1.95
LM337MP	1.15
LM338K	6.95
LM339N	.99
LM340K-5	1.35
LM340K-12	1.35
LM340K-15	1.35

LM340T-5	1.25
LM340T-12	1.25
LM340T-15	1.25
LM341P-5	.75
LM341P-12	.75
LM341P-15	.75
LM342P-5	.69
LM342P-12	.69
LM342P-15	.69
LM348N	1.25
LM350K	5.75
LF351N	.60
LF353N	1.00
LF355N	1.10
LF356N	1.10
LM358N	1.00
LM359N	1.79
LM370N	4.49
LM373N	3.25
LM377N	2.95
LM380N	1.25
LM381N	1.95
LM382N	1.79
LM384N	1.95
LM386N-3	1.29
LM387N	1.45
LM389N	1.35
LM392N	.69
LF398N	4.00
LM399H	5.00
TL494CN	4.49
TL496CP	1.75
NE510A	6.00
NE529A	4.95
NE531H	3.95
NE536H	6.00
NE540H	6.00
NE544N	4.95
NE550A	1.30
NE555V	.39
LM556N	.99
NE564N	3.95
LM565N	1.25
LM566CN	1.95
LM567V	1.25

NE570N	4.95
LM702H	.79
LM703CN	.89
LM709N	.29
LM710N	.79
LM711N	.79
LM723N	.69
LM733N	1.00
LM739N	1.19
LM741CN	.35
MC1741SCG	3.00
LM747N	.79
LM748N	.59
LM1014N	2.75
LM1310N	1.95
LM1458CN	.59
LM1488N	1.25
LM1489N	1.25
LM1496N	1.95
LM1556V	1.75
LM1800N	2.95
LM1877N-9	3.25
LM1889N	3.20
LM1896N	1.75
LM2002T	1.49
LM2877P	2.05
LM2878P	2.25
LM2896P-1	2.25
LM3189N	2.95
LM3900N	.69
LM3905CN	1.25
LM3909N	1.15
LM3914N	3.95
LM3915N	3.95
LM3916N	3.95
RC4136N	1.25
RC4151NB	3.95
RC4194TK	5.95
RC4195TK	5.49
KB4428	4.25
KB4429	5.95
LM4500A	3.25
ICL8038B	4.95
LM13080N	1.29
LM13600N	1.49
75138N	1.95
75450N	.89
75451CN	.39

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (Solid) CAPACITORS

.1/35V	.39	.34	.29	1.5/35V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/35V	.51	.45	.34
.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

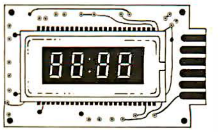
MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

Circle 314 on inquiry card.

National Semiconductor Clock Modules

12VDC AUTOMOTIVE/ INSTRUMENT CLOCK



APPLICATIONS:
- In-dash autoclocks
- After-market auto/ RV clocks
- Aircraft-marine clks.
- 12VDC oper. instru.
- Portable/battery powered instrumnts.

Features: Bright 0.3" green display. Internal crystal timebase. ± 0.5 sec./day accur. Auto. display brightness control logic. Display color filterable to blue, blue-green, green & yellow. Complete—just add switches and lens.

MA1003 Module $16.95

MA1023	.7" Low Cost Digital LED Clock Module	8.95
MA1026	.7" Dig. LED Alarm Clock/Thermometer	18.95
MA5036	.3" Low Cost Digital LED Clock/Timer	6.95
MA1002	.5" LED Display Dig. Clock & Xformer	9.95



National Semiconductor RAM SALE

MM5290N-4 (MK4116/UPD416) . . $4.95 each
16K DYNAMIC RAM (250NS)
(8 EACH $39.95) (100 EACH $450.00/lot)

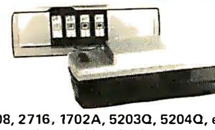
MM5290J-2 (MK4116/UPD416) . . $6.95 each
16K DYNAMIC RAM (150NS)
(8 EACH $49.95) (100 EACH $550.00/lot)

MM5298J-3A .... $3.25 each
8K DYNAMIC RAM (LOW HALF OF MM5290J) 200NS
(8 EACH $23.95) (100 EACH $250.00/lot)

MM2114-3 .... $5.95 each
4K STATIC RAM (300NS)
(8 EACH $43.95) (100 EACH $450.00/lot)

MM2114L-3 .... $6.25 each
4K STATIC RAM (LOW POWER 300NS)
(8 EACH $44.95) (100 EACH $475.00/lot)

EPROM Erasing Lamp



- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch.
- Special conductive foam liner eliminates static build-up.
- Built-in safety lock to prevent UV exposure.
- Compact — only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips.

UVS-11E $79.95

Jumbo 6-Digit Clock Kit



- Four .630" ht. and two .300" ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE747 .... $29.95

6-Digit Clock Kit



- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

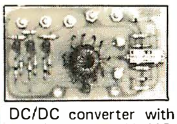
JE701 .... $19.95

Regulated Power Supply



Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3½" x 5" x 2"H

JE200 .... $14.95



ADAPTER BOARD —Adapts to JE200— ±5V, ±9V and ±12V

DC/DC converter with +5V input. Toriodal hi-speed switching XFMR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

JE205 .... $12.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

INS8080A	CPU	6.50
DP8212	8-Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm. Element	16.95
DP8251	Prog. Comm. I/O (USART)	7.95
DP8253	Prog. Interval Timer	14.95
DP8255	Prog. Peripheral I/O (PPI)	9.95
DP8257	Prog. DMA Control	19.95
DP8259	Prog. Interrupt Control	14.95
DP8275	Prog. CRT Controller	49.95
DP8279	Prog. Keyboard/Display Interface	19.95
DP8300	Octal Bus Receiver	6.95
DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95

6800/6800 SUPPORT DEVICES

MC6800	MPU	14.95
MC6802CP	MPU with Clock and RAM	19.95
MC6810APJ	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	10.95
MC6830L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	13.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	15.95
CDP1802	CPU	19.95
2650	MPU	16.95
IDM2901ADC	CPU—4-Bit Slice (Com. Temp. Grade)	19.95
MCS6502	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-6	MPU—8-Bit (6MHz)	16.95
INS8039N-6	CPU—Sgl. Chip 8-Bit (128 bytes RAM)	19.95
INS8040N-6	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—64 Bytes RAM	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
P8085	CPU	19.95
INS8900	CPU—16-Bit	29.95
TMS9900JL	MPU—16-Bit	49.95

SHIFT REGISTERS

MM500H	Dual 25-Bit Dynamic	.50
MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402	256-Bit Dynamic	3.95
MM5013	1024-Bit Dynamic/Accumulator	1.95
MM5016H	500/512-Bit Dynamic	.89
MM5034N	Octal 80-Bit	9.95
MM5035N	Octal 80-Bit	9.95
2504V(1404A)	1024-Bit Dynamic	3.95
2518N	Hex 32-Bit Static	4.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
2525V	1024-Bit Dynamic	2.95
2527V	Dual 256-Bit Static	2.95
2528V	Dual 250-Bit Static	4.00
2529V	Dual 240-Bit Static	4.00
2532N	Quad 80-Bit Static	2.95
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

AF100-1CN	Universal Active Filter 2.5%	5.95
AF121-1CJ	Touch Tone Low Pass Filter	19.95
AF122-1CJ	Touch Tone Low Pass Filter	19.95
LM308AH	Super Gain Op Amp	1.00
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp. Comp. Prec. Ref. (.5ppm/C°)	4.95
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
DAC0806LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

ADC0809CCN	8-Bit A/D Converter (8-Ch. Multi.)	5.25
ADC0817CCN	8-Bit A/D Converter (16-Ch. Multi.)	10.95
DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	8.95
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	8.49
DAC1022LCN	10-Bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	1.19
AY-5-1013	30K BAUD UART	5.95

RAM'S

1101	256x1 Static	1.49
1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
21L02	1024x1 Static	1.95
2111 (8111)	256x4 Static	3.95
2112	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	5.95
2114L	1024x4 Static 450ns Low Power	6.95
2114-3	1024x4 Static 300ns	7.49
2114L-3	1024x4 Static 300ns Low Power	7.95
2117	16, 84x1 Dynamic 550ns (housemarked)	4.95
4116 (UPD416)	16K Dynamic 250ns	4.95
MM2147J	4096x1 Fast 70ns	19.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.25
MM5280/2107	4096x1 Dynamic	4.95
MM5290J-2 (4116)	16K Dynamic 150ns (UPD416)	6.95
MM5298J-3A	8K Dyn. 200ns (lower ½ of MM5290J)	4.95
7489	16 x4 Static	1.75
UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	14.95
TMS4045	1024x4 Static	14.95

PROMS/EPROMS

1702A	2K UV Erasable PROM	5.95
2708	8K EPROM	9.95
TMS2716	16K EPROM (-5V, +5V, +12V)	19.95
2716 Intel (2516) TI	16K EPROM (Single +5V)	17.95
2732 Intel (2532) TI	32K EPROM	49.95
2758	8K EPROM (450ns) (Single +5V)	7.95
5203	2048 PROM	14.95
82S23 (74S188)	32x8 PROM (Open Collector)	4.95
82S115	4096 Bipolar PROM	19.95
82S123 (74S288)	32x8 Tri-State Bipolar PROM	4.95
82S185	8K PROM	29.95

ROM'S

2513 (2140)	Character Generator (Upper Case)	9.95
2513 (3021)	Character Generator (Lower Case)	9.95
2516N	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

NMOS READ ONLY MEMORIES

MCM66710P	128x9x7 ASCII Shifted w/Greek	13.50
MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

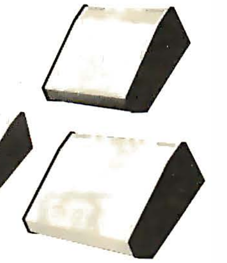
SPECIAL FUNCTION

DS0025CN	Dual MOS Clock Driver (5MZ)	3.50
DS0026CN	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2651N	Communication Chip	19.95
MM58167N	Microprocessor Real Time Clock	8.95
MM58174N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402MN	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Buss Int.	7.49
COP470N	32-Seg. VAC Fluor. Driver (20-pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

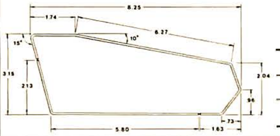
AY-5-9100	Push Button Telephone Dialer	14.95
AY-5-9200	Repertory Dialer	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	11.95
HD0165-5	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.49
74C923	Keyboard Encoder (20 keys)	5.75
MM53190N	Push Button Pulse Dialer	7.95
MM57499N	96/144-Key Serial Keyboard Encoder	8.95

DESIGNERS' SERIES
Blank Desk-Top Electronic Enclosures



- High strength epoxy molded end pieces in mocha brown finish.
- Sliding rear/bottom panel for service and component accessibility.
- Top/bottom panels .080 thk alum. Alodine type 1200 finish (gold tint color) for best paint adhesion after modification.
- Vented top and bottom panels for cooling efficiency.
- Rigid construction provides unlimited applications.

CONSTRUCTION:
The "DTE" Blank Desk Top Electronic Enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home. The end pieces are precision molded with an internal slot (all around) to accept both top and bottom panels. The panels are then fastened to ¼" thick tabs inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear/bottom panel slides back on slotted tracks while the rest of the enclosure remains intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be painted to match any panel color scheme.



Enclosure Model No.	Panel Width	PRICE
DTE-8	8.00"	$29.95
DTE-11	10.65"	$32.95
DTE-14	14.00"	$34.95

$10.00 Min. Order — U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage—Add 5% plus $1 Insurance

Spec Sheets — 25¢
Send 41¢ Postage for your FREE 1981 JAMECO CATALOG

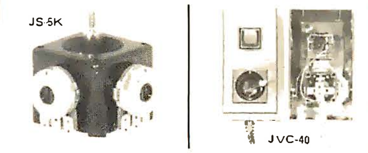
NEW 1981 CATALOG

Jameco ELECTRONICS

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS — WORLDWIDE
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3/81 PRICES SUBJECT TO CHANGE

JOYSTICKS



JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JVC-40	40K (2) Video Controller in case . . .	$5.95

AC and DC Wall Transformers



Ideal for use with clocks, games, power supplies or any other type of AC or DC application.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12 VAC 250mA	$3.95
AC 500	117V/60Hz	12 VAC 500mA	$4.95
AC1000	117V/60Hz	12 VAC 1 amp	$5.95
DV9200	117V/60Hz	9 VDC 200mA	$3.25
DC 900	120V/60Hz	9 VDC 500mA	$3.95

CONNECTORS



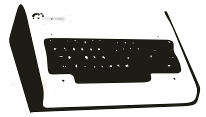
DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
UG88/U	BNC Plug	$1.79
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .49
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
UG260/U	BNC Plug	$1.79
UG1094/U	BNC Bulkhead Recp.	$1.29

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
★8 ea. MM5290 (UPD416/4116) 16K Dyn. Rams (*NS)
★Documentation for Conversion

TRS-16K2 *150 NS $49.95
TRS-16K4 *250NS $39.95

JE610 ASCII Encoded Keyboard Kit



The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10 mA for operation. Features: 60 keys generate the 126 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector. Size: 3½"H x 14½"W x 8¾"D

JE610/DTE-AK (as pictured above) . . . $124.95
JE610 Kit 62-Key Keyboard, PC Board, & Components (no case) . . . . $ 79.95
K62 62-Key Keyboard (Keyboard only) . . . $ 34.95
DTE-AK (case only — 3¼"Hx11"Wx8¾"D) $ 49.95

JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD



The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¼"W x 8¾"D

JE600/DTE-HK (as pictured above) $99.95
JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) . . $59.95
K19 19-Key Keyboard (Keyboard only) $14.95
DTE-HK (case only — 3½"Hx8¼"Wx8¾"D) $44.95

7400

SN7400N	19	SN74123N	.59
SN7401N	22	SN74125N	.39
SN7402N	22	SN74126N	.44
SN7403N	.22	SN74126N	.59
SN7404N	22	SN74132N	.69
SN7405N	23	SN74136N	95
SN7406N	23	SN74139N	95
SN7407N	23	SN74141N	69
SN7408N	26	SN74142N	2.95
SN7409N	23	SN74143N	2.95
SN7410N	22	SN74144N	2.95
SN7411N	29	SN74145N	62
SN7412N	29	SN74147N	1.95
SN7413N	39	SN74148N	1.20
SN7414N	59	SN74150N	.99
SN7416N	.29	SN74151N	.67
SN7417N	29	SN74152N	.67
SN7420N	22	SN74153N	.67
SN7421N	35	SN74154N	1.19
SN7422N	29	SN74155N	.82
SN7423N	29	SN74156N	.89
SN7425N	.29	SN74157N	.69
SN7426N	29	SN74158N	1.65
SN7427N	29	SN74160N	.95
SN7429N	45	SN74161N	95
SN7430N	23	SN74162N	.89
SN7432N	29	SN74163N	.87
SN7437N	29	SN74164N	.97
SN7438N	29	SN74165N	97
SN7439N	29	SN74166N	1.20
SN7440N	24	SN74167N	1.95
SN7441N	79	SN74170N	1.69
SN7442N	57	SN74172N	5.95
SN7443N	79	SN74173N	79
SN7444N	79	SN74174N	89
SN7445N	.79	SN74175N	.89
SN7446N	.79	SN74176N	.85
SN7447N	59	SN74177N	.85
SN7448N	.79	SN74179N	1.80
SN7450N	.23	SN74180N	.75
SN7451N	.23	SN74181N	1.75
SN7453N	.23	SN74182N	.75
SN7454N	.23	SN74184N	1.95
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SN7473N	.38	SN74191N	1.15
SN7474N	.36	SN74192N	.85
SN7475N	.38	SN74193N	.85
SN7476N	.36	SN74194N	.85
SN7479N	4.60	SN74195N	.85
SN7480N	.59	SN74196N	.85
SN7481N	1.10	SN74197N	.85
SN7482N	1.10	SN74196N	1.39
SN7483N	.55	SN74199N	1.39
SN7485N	.65	SN74221N	1.39
SN7486N	39	SN74251N	.95
SN7489N	1.75	SN74273N	1.05
SN7490N	.39	SN74279N	.89
SN7491N	65	SN74283N	2.15
SN7492N	.52	SN74284N	3.90
SN7493N	.49	SN74285N	3.90
SN7494N	.72	SN74290N	1.25
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SN7496N	.72	SN74365N	.68
SN7497N	3.10	SN74366N	.68
SN74100N	.99	SN74367N	.79
SN74107N	.32	SN74368N	.79
SN74109N	.53	SN74390N	1.90
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CD4024	.79	CD4516	1.69
CD4025	.38	CD4518	1.39
CD4027	.65	CD4520	1.39
CD4028	.85	CD4555	4.95
CD4029	1.29	CD4556	.99
CD4030	.45	CD4566	2.25
CD4031	3.25	74C00	.39
CD4032	2.15	74C02	.39
CD4034	3.25	74C04	.39
CD4035	.95	74C08	.49
CD4037	1.95	74C10	.49
CD4040	1.29	74C14	1.65
CD4041	1.25	74C20	.39
CD4042	.95	74C30	.39
CD4043	.85	74C32	.99
CD4044	.85	74C42	1.85
CD4046	1.75	74C48	2.39
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CD4050	.69	74C89	4.95
CD4051	1.10	74C90	1.65
CD4052	1.10	74C93	1.85
CD4053	1.10	74C95	1.85
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CD4056	2.95	74C151	2.49
CD4059	9.95	74C154	3.50
CD4060	1.39	74C157	2.10
CD4066	.75	74C160	2.39
CD4069	.35	74C161	2.30
CD4070	.49	74C163	2.39
CD4071	.35	74C164	2.39
CD4072	.35	74C173	2.59
CD4073	.35	74C174	2.75
CD4075	.35	74C175	2.75
CD4076	1.29	74C192	2.39
CD4077	.35	74C193	2.39
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74LS00N	.35	74LS164N	1.19
74LS01N	28	74LS165N	89
74LS02N	.28	74LS166N	2.48
74LS03N	28	74LS168N	1.89
74LS04N	39	74LS169N	1.89
74LS05N	28	74LS170N	1.99
74LS08N	39	74LS173N	.89
74LS09N	39	74LS174N	.99
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74LS153N	.79	74LS393N	1.95
74LS154N	2.49	74LS395N	1.70
74LS155N	1.19	74LS399N	2.95
74LS156N	99	74LS424N	2.95
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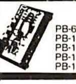
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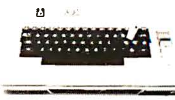
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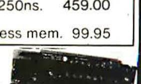
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SN76477 TI Sound Generator	3 95
MM5320/21 TV Synch Gen	9 95
MM5369 Prescaler	3.95
LM1889 RF Modulator	3 95
MM57100 NSC Color TV	6 95
MM57104 Clock Gen.	3.75
RF Modulator w/Audio	8.95
M&R Modulator	2995

WAVEFORM GEN.

8038 Function Gen.	395
MC4024VCO	2 95
LM566 VCO	1 95
XR2206 Function Generator	5.25

SHIFT REGISTERS

MM500H Dual25	50
MM5056N Dual 256	2 95
MM5060N Dual 128	2 95
2510A Dual 100	1 95
2847 Quad 80	4.95
3341 Dual 80	4 95
3351 40 x 9 FIFO	17.95
3357 Quad80	8 95
9403 16 x 4 FIFO	24.95
9408 10 Bit Sequencer	9.95
3347	5 95

CTS DIPSWITCHES

CTS206-2	1.75	CTS206-7	1 75
CTS206-4	1.75	CTS206-8	1 95
CTS206-5	1.75	CTS206-9	1 95
CTS206-6	1.75	CTS206-10	1 95

CONNECTORS (GOLD)

DB25P (RS232)	3 25
DB25S Female	3.75
Hood	1.25
Set w/Hood. Sale	$7.50
22/44 W/W. S/T. KIM	2 95
43/86 W/W. S/T. MOT	6 50
50/100 S-100 Connector w/w	4.95
50/100 S-100 Connector s/t	3.95

NAKED PC

Z-80 CPU (Ithaca)	$34.95
8080A CPU	34.95
8K Static RAM (Logos)	24.95
16K Static RAM (2114)	29.95
32K Static RAM (2114)	29.95
8K Eprom (2708)	24.95
1702 Eprom Board	3000
2708/2716 Eprom (Ithaca)	34.95
2708/2716 Eprom (WMC)	30.00
Realtime Clock	34.95
ACP ProtoBd (3M Conn.)	27.95
Vector 8800 Proto	22.20
Vector 8803 11 slot MB	29.95
ACP Extender w/Conn	18.95
Video Interface (SSM)	31.95
Parallel Interface (SSM)	31.95
13 Slot MotherBoard (WMC)	32.95
9 Slot MotherBoard (WMC)	29.95
8 Slot Mother (expandable)	3495
Proc-Tech Bare Boards	CALL
WMC Floppy PCB	34.95

COMPUTER SPECIALS

DISCOUNTS!

	LIST	SALE
Apple II Plus w/16K	1195.	990.
PET 2001-16N	995.	895.
Exidy Sorcerer w/16K		1099
Cromemco Sys III	6990	6290.
Horizon I w/32K		CALL
Pascal Microengine	1995.	1595.
IPSI 1620 DiabloRO	3295.	2695.
Anadex DP 8000	995.	875.
Centronics Micro S-1	595.	525.
Soroc IQ 120	995.	795.
Teletype Model 43	1349.	1150.
HiPlot Plotter	1085.	899.
HiPlot Digitizer	795.	735.
Intertube II	895.	784.
Atari 800	999.	750.
Atari 400	549.	449.
TI 99/4	1150.	1025.
Leedex 12" Monitor	149.	139.
Centronics 737	995.	899.
Trencom T-100	375.	349.
Trencom T-200	595.	525.
Sanyo 9" Monitor	220.	169.
Sanyo 15" Monitor	295.	249.
Mot 22MHz Monitor	296.	219.

SOCKET SPECIALS

14 Pin w/w-2L	$ .35
18 Pin w/w-2L	.55
20 Pin w/w-2L	.75
18 Pin s/t	.15
22 Pin s/t	.15

Call for volume pricing.

TERMS: Use check, M/C, VISA, AMEX, CB, or COD. COD requires 25% deposit. Charge Orders please include expiration date. Foreign pay U.S. Funds. Order by phone, mail or TWX. MINIMUM $10.00. Please include magazine issue and phone no. SHIPPING U.S.A. add $2.00 for first 2 lbs. For surface add 30¢ for additional lbs. For air add 70¢ for additional lbs. FOREIGN Add 10% shipping and handling. COD's $1.85 extra. Not responsible for typos. Some items subject to prior sale. We reserve right to limit quantities, some items subject to precious metal adder. Retail pricing may vary from Mail Order. We reserve the right to substitute manufacturer.

RETAIL STORES OPEN MON-SAT

STORE #1 — 1310 "B" E. Edinger, Santa Ana, CA 92705 — Showrooms, Retail, Warehouse
STORE #2 — 674 El Camino Real, Tustin, CA 92680 — Specializing In Systems

P.O. Box 17329 Irvine, Calif. 92713
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Santa Ana, CA92705 TWX: 910-595-1565

Circle 315 on inquiry card.

DEALS □ DEALS □ DEALS

OUR BUYERS ARE IN CONTACT WITH EVERY MAJOR SUPPLIER AND O.E.M. BUY HERE AT 1000 PIECE

QUANTITY PRICES

ALL MERCHANDISE 100% GUARANTEED! 15 DAY FULL CASH REFUND!

U.S. MICRO SALES

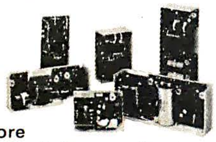
664 N. MICHIGAN AVE. ★ SUITE 1010 ★ CHICAGO, ILLINOIS 60611
CALL TOLL FREE: 1-800-435-9357 ★ MONDAY thru SATURDAY
(ILLINOIS RESIDENTS CALL: 815-485-4002) ★ 8:00 a.m. to 6:30 p.m.

TERMS: Prepayment – C.O.D. up to $100.00 – M/C, Visa
Please allow personal check to clear before shipment.

WRITE FOR FULL CATALOG!

JUST HOT STUFF

POWER SUPPLIES



If you can beat these prices we will be truly amazed. OEM's at 500 lot pay more than this. Call or write for full spec. sheets.

DISK POWER SUPPLIES				
PRIAM–SHUGART–CENTURY–MICROPOLIS				
+5V @ 9A	–5V @ .8A	+24V @ 7A	US-384	89.00
SHUGART – SIEMANS – MPI 5¼″				
+5V @ .5A	+12V @ .9A		US-340	33.50
+5V @ 2A	+12V @ 4A		US-323	56.25
SHUGART – SIEMANS – CDC 8″				
+5V @ 1A	–5V @ .5A	+24V @ 1.5A	US-205	52.50
+5V @ 2A	–5V @ .5A	+24V @ 3A	US-206	69.00
+5V @ 3A	–5V @ .6A	+24V @ 5A	US-162	89.00
+5V @ 1.7A	–5V @ 1.5A	+24V @ 2A	US-272	69.00
+5V @ 2A	+12V @ .4A	–12V @ .4A	US-HTAA	37.50

TELEVIDEO 912C

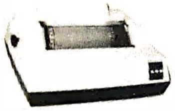
SOROC IQ120– $675.00
Televideo 912C– 665.00
ADDS R-25 – 710.00



Also have 920C, SOROC, HAZELTINE, etc. What we don't have is room on this page. Call Toll Free 800 number for prices.

C-ITOH PRINTER

$499.00



Look closely at the photo and see other adds in this rag at $995.00. Perfect units, warranteed. Only 500 pcs. Same story, manufacturerer had too many.

S-100 CARD EXTENDER

$12.50

(Gold Contacts)



As long as there is a price war, we will fight your battle. Compare at your local Dept. store and buy U$ MICRO.

MEMOREX – VERBATUM – WABASH
BASF FLOPPIES

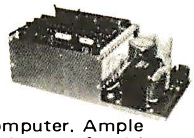
BOX OF 10 ONLY:

5¼″	SOFT	$2.65 ea.
5¼″	HARD 10	2.65 ea.
5¼″	HARD 16	2.65 ea.
8″	SOFT 1D	3.25 ea.
8″	SOFT 2D	3.85 ea.
8″	SOFT 2DDS	5.00 ea.

SPECIAL OF THE QUARTER

S1-MOD (KIT)

$189.00 MADE IN USA



Complete S-100 12 Slot Computer. Ample system power with regulated power for drives. Excellent for Subsystem or Hobby use. 4 hours to build. (6 conn. incl., less fans)

DUAL DRIVE SUBSYSTEM

$995.00



2 SHUGART 801R POWER SUPPLY

If this looks like a Lobo Drive System, don't be fooled. Just because it looks like one, works like one, smells like one, and tastes like one (?) doesn't mean it has to cost like one!

EXPANDABLE RAM
★SPECIAL★SPECIAL★SPECIAL★

This is the best all around 64K board you can buy. If after you see it, you don't agree return for full refund. Bank Select by extended address lines or I.O. 40H.

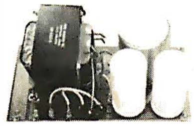


★$389.00 A&T★

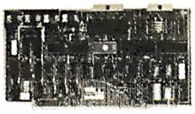
S-100 POWER

$79.50

Simple Brute Force! S-100 Power Supply, 30A @ +8V, 6A @ +16V, 6A @ –16V, PC Board Design.



Z–80 CPU (KIT)



The first time this world popular CPU offered in Kit. 2 serial, 3 parallel, CTC, EProm Z-80 at 4 mhz. Software buad rate, etc. (less Prom & cable) $212.00

12 SLOT MOTHER



We have connectors and power supply too. Start your system with quality components. Terminated. **$22.50**

CONNECTORS $2.50 ea.

FANS $14.95

These are brand new, in the box fans. Not noisey bearing pullouts. Never again at these low prices!



3-1/8″ 4-5/8″

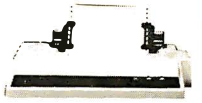
SPECIALS OF THE MONTH

4116s
200 NS

Expansion 16K Dynamic RAMs for Apple, TRS-80 S-100 systems. T.I., Mostek Intel, Call for manufacturer. **$3.75**

DIP-80 $399.00

Don't be mislead by this LOW price. This is a rugged 100% Duty Cycle 7 by 7 Dot Matrix Printer. Brand new, factory warr.



• RS-232 ADD $65.00
• TRACTOR FEED ADD $70.00

2114s



$3.45

200 NS

One of the world's two most popular STATIC RAMs. Factory prime tested units. Sold in lots of 8 only. FUJITSU, HITACHI, etc.

TMS-4044 / MM-5257 / INTEL 2147

$4.25

250 NS

The other of the world's most popular STATIC RAMs. This one is 4K by 1 organization. Don't buy Gold, buy these, the price won't last!

2716s $13.50 (450 NS)
2708s $6.95 (450 NS)

Remember when 2716s were $50.00 and hard to get? These units are so beautiful it's hard to part with them. But we will, for a small price. Guaranteed!

SHUGART DRIVE



8″ 851R $585.00

8″ 801R **$395.00**

Manufacturer had too many, buys at 1000 piece rate, sales dropped, so we got'em. Fantastic buy, get them while they last! Full warranty.

SIEMANS DRIVE

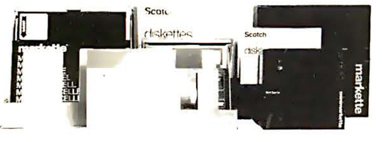
8″ 120-8 **$375.00**

Very Special Price on these BRAND NEW current production units. Add $10.00 for Extended 1 Year Warrantee!

Circle 316 on inquiry card.

California Digital

Post Office Box 3097 B • Torrance, California 90503



DISKETTES

FREE PLASTIC LIBRARY CASE INCLUDED WITH THE PURCHASE OF EVERY BOX OF DISKETTES

Private labeled for California Digital by one of the most respected producers of magnetic media. Each diskette is certified double density at 40 tracks. To insure extended media life each diskette is manufactured with a reinforced hub-hole. And of course, a plastic library case is included with every box of diskettes. MMD-CD5(01)(10) Please specify computer or required sectors.

$24.95 BOX

Ten boxes $22.75 One hundred boxes $21.50

MINIDISKETTES	Box	10 boxes		Box	10 boxes
Memorex 3401	$27.00	$25.00	Scotch 744(0)(10)(16)	$31.00	$29.00
Verbatim 525(01)(10)	29.00	27.00	Dysan	45.00	43.00

EIGHT INCH	Scotch	box	10 bx.	Dysan	box	10 bx.	MRX	box	10 bx.
Single side/single den.	740-0	$35.	$33.	3740/1	$49.	$47.	3060	$ 5.	$ 3.
Single side/double den.	741-0	45.	43.	3740/1d	75	73.	3090	37.	35.
Single side/32 sector	740-32	35.	33.	na.			na.		
Double side/ double D.	743-0	65.	59.	na.			3115	49.	45.

SCOTCH brand head cleaning kit. $24.95 MMA-CK(5)(8) please specify 5 1/4 8"
Prices available on request for: tape, cartridges, diskpacks, volumn diskettes.

MEMORY



TRS-80 APPLE II $29

16k memory (8) 4116's

Installation is simple. Anyone who has ever changed a spark plug should be able to up-grade his microcomputer.
How can California Digital offer these memory up-grade sets at 25% below our competition? Simple, we buy in volume, wholesale to dealers and sell the balance directly to owners of personal microsystems. These 16K dynamic memory circuits are factory prime and unconditionally guaranteed for one full year. NOW, before you change your mind, pick up the telephone and order your up-grade memory from California Digital. Add $3 for TRS80 jumpers.

STATIC	1-31	32-99	100-5C	-999	1K+
21L02 450nS.	1.19	.99	.95	.90	.85
21L02 250nS.	1.49	1.39	1.25	*	*
2114 1Kx4 450	5.95	5.50	5.25	4.75	4.50
2114 1Kx4 300	8.95	8.50	8.00	*	*
4044 4Kx1 450	5.95	5.50	5.25	*	*
4044 4Kx1 250	9.95	9.50	9.00	*	*
4045 1Kx4 450	8.95	8.50	8.00	*	*
4045 1Kx4 250	9.95	9.50	9.00	*	*
5257 low pow.	5.95	5.50	5.00	4.80	4.60

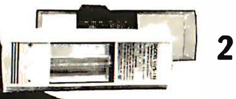
2716 EPROM SALE $9.95

We have slashed price in an effort to reduce our over stocked inventory. These are single five volt EPROMs manufactured by one of the Worlds largest producers of semiconductors. All are first quality prime devices. Ceramic 450nS.

FREE

Ultra-Violet Products UVS 11-E

UV EPROM ERASER



With purchase of FORTY 2716 EPROM's

$79 value

NEW from Shugart Technology 5 Megabyte Hard Disk Drive



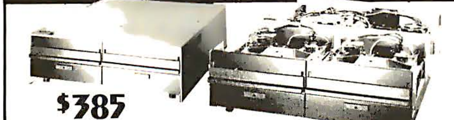
Packaged in the same physical size as the industry standard 5 1/4" minifloppy disk drive. The micro-Winchester stores thirty times as much data (6.38 megabytes unformatted), accesses data twice as fast (170 milliseconds) and transfers data twenty times faster (5.0 megabits per second.)

The ST506 is factory sealed to protect the media from environmental contaminates. Requires only DC voltage.

Dual California Digital 5 1/4" enclosure. ST506 drive and power supply. **$1500**

Shugart Associates SA400 removable media disk drive for above package. add: **$300**
S-100 & Apple controller scheduled for spring release.

Shugart Associates



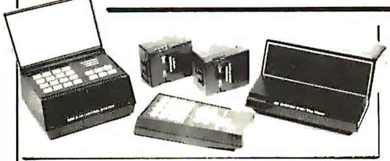
$385

801/ R Disk Drive 15 lbs.

Shugart 801/R with CP 206 power supply, muffin exhaust fan, complete in dual enclosure with all the necessary harnessing cables. Documentation included. 36 pounds. MSD-1801 **$795**

Same as above but with two Shugart 801R disk drives. 50 pounds. MSD-2801 **$1195**

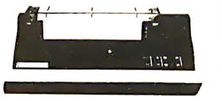
Disk drive cable. 6 feet 50 conductor with edge card connector at both ends. WCA-650S $25.00
Export Disk drives. 220V. 50MHz add $50.00 per disk drive.



BSR SYSTEM X·10

The new BSR timer runs your home just like clockwork. Turns on lamps and appliances while your away from home. Completely compatible with your existing System X-10 devices.

BSR Timer eight channel	$65.00	Appliance Module 500 W.	$13.95
Master control console	34.95	Lamp Module 300 Watts	13.95
Ultrasonic Controller	19.95	NEW full control wall switch	14.50

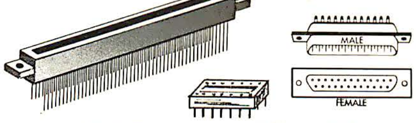


TI-810

$1495

List $1895

CONNECTORS



GOLD EDGE CONNECTORS	each	10+
S-100 .125" centers		
Imsai solder .250" row	$2.95	$2.50
Imsai wire wrap (TI)	3.95	3.50
Sullins Hi-Rel. .250'	4.50	4.00
Sullins Hi-Rel. W/W	5.35	4.90
Sullins / Altair .140"	4.95	4.50
.156" Centers (standard)		
22/44 Kim Eyelet	2.50	2.15
36/72 Digital Group S/T	5.95	5.50
36/72 Digital Group W/W	6.60	6.15
43/86 Motorola 6800 S/T	6.60	6.15
43/86 Moto. 6800 W/W	7.00	6.85

INTEGRATED CIRCUIT SOCKETS

	Low Profile each	Low Profile 100+	Wire Wrap each	Wire Wrap 100+
8 pin	$.10	$.09	$.46	$.41
14 pin	.10	.09	.46	.41
16 pin	.12	.11	.50	.45
18 pin	.15	.13	.68	.61
24 pin	.26	.24	.94	.87
40 pin	.42	.40	1.60	1.47

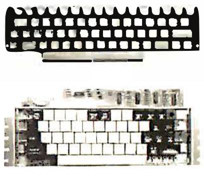
"D" Type	each	10-24	25+
DE9P male	$1.60	$1.40	$1.30
DE9S female	2.25	2.00	1.90
DE hood	1.50	1.35	1.20
DA15P male	2.35	2.15	2.00
DA15S female	3.25	3.10	2.90
DA hood 2/P	1.60	1.35	1.30
DB 25P male	2.50	2.35	2.25
DB 25S female	3.35	3.15	3.05
DB hood 2/P	1.35	1.15	1.05
DC37P male	4.20	4.00	3.70
DC37S female	6.00	5.75	5.50
DC hood 2/P	2.25	2.00	1.75
DD50P male	5.50	5.10	4.75
DD50S female	9.40	8.60	8.00
DD50 hood 2/P	2.60	2.40	2.10
CENTRONICS			
57-30360	7.95	6.75	5.75
RIBBON CABLE CONNECTORS			
17/34 5" disk	4.85	4.15	3.95
20/40 TRS-80	5.65	5.05	4.70
25/50 8" disk	5.90	5.15	4.90

SURPLUS



IBM 2980 SELECTRIC BANK TERMINAL $250

The IBM 2980 terminal was designed to be located at each tellers station in a branch bank. Information entered into the terminal would instantaneously adjust the customers account at the computer. A record of the transaction would be posted into the customers passbook and simultaneously recorded onto a continuous 40 column paper roll located within the terminal. USED
Each unit is supplied with print ball, ribbon and documentation. 77 lbs. SPC-2980



KEY-BOARDS $24.95

62 key Hytek non-encoded keyboard. New surplus purchased from the residual inventory of the Altair computer. KEY-HK

50 key Micro-Switch brand Hall Effect keyboard. (USED). Ten bit TTL level output. Requires +5 volt. KEY-DT2 3 lbs. Same unit with ASCII encoder. Add $12.00

Also available Maxi-switch NEW hexadecimal keyboard. Glass reed. TTL $49. HEX

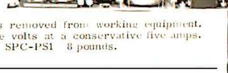


$139.50

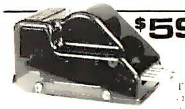
PORTABLE DATA ENTRY SYSTEM

These used data terminals were originally designed for retail store order entry systems. The operator enters the inventory control number, merchandise on hand and the unit price. After all pertinent data has been entered, the main warehouse is telephoned, the handset is placed in the acoustic coupler an all the recorded information is transmitted back the master computer.
Each system includes: Cassette drive unit; Removable hex keyboard with LED display; Five Gould "D" NiCads with charger; Acoustical coupler and DB25 cable. All units removed from service in working condition. Original cost over $2,500.

Regulated Power Supply 5 VOLT 5 AMP $9.95



This USED surplus power supply was removed from working equipment. Pass transistor regulation outputs five volts at a conservative five amps. Suitable for TTL hobby applications. SPC-PS1 8 pounds.



$59 Sankyo Magnetic Card Transport

This Sankyo card transport is capable of storing and retrieving over 400 characters of data from a single 2 x 4" HP style magnetic data card. Motorized mechanism pulls the magnetic card across the four channel read/write head in under two seconds. Ideal for any data processing application where small amounts of information must be randomly retrieved. Original cost over $200.00 Documentation and sample card included. New surplus. SPC-SCR

ATARI RF MODULATOR



Broadcast computer output video onto channel 3 or 4 of any standard television. Recommended for the Apple Computer or any other computer that outputs composit video. Also suitable for video cameras. Supplied with coax cable and instructions. Requires 1.5-5V. New surplus. SPC-RFM

$9.95



DATA INPUT TERMINAL

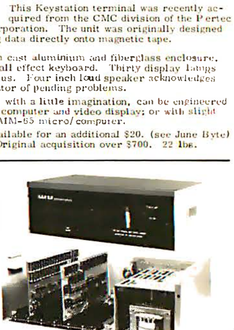
This Keystation terminal was recently acquired from the CMC division of the Pertec Corporation. The unit was originally designed for inputing data directly onto magnetic tape.

The system is comprised of a premium cast aluminium and fiberglass enclosure, along with a Honeywell / Microswitch hall effect keyboard. Thirty display lamps advise the operator of the systems status. Four inch loud speaker acknowledges acceptance of data and alerts the operator of pending problems.

But most of all this "USED" terminal, with a little imagination, can be engineered to make the perfect home for an S-100 computer and video display; or with slight modification will accept the Rockwell AIM-65 micro/computer.

Five volt regulated power supply is available for an additional $20. (see June Byte) All units are in excellent condition. Original acquisition over $700. 22 lbs.

WESTERN UNION ENCLOSURE



These enclosures were manufactured for Western Union by Universal Technology. The exact purpose of the product is still a mystery but the enclosure is ideally suited for an S-100 motherboard with shielded power supply. Removable hood and plexiglas front make this enclosure an attractive home for any hobby product. New surplus in factory boxes supplied with three 22/44 edge connectors; DB 25S communications connector; six foot grounded power cord and more. Inside dimensions: 19" x 10 1/2" x 6 7/8". Shipping weight 8 lbs. **$24.95**

VISA

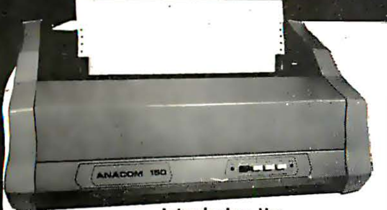
master charge THE INTERBANK CARD

All merchandise sold by California Digital is premium grade.
Shipping: First five pounds $2.00; each additional add $.40
Foreign orders 10% shipping. Excess will be refunded.
California residents add 6% sales tax. COD's discouraged.
Open accounts extended to state supported educational institutions and companies with a "Strong Dun & Bradstreet."
Warehouse: 15608 Inglewood Blvd. Visitors by appointment.

TOLL FREE ORDER LINE
(800) 421-5041
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California Digital

Post Office Box 3097 B • Torrance, California 90503



Full 136 Characters for the price of 80

DURABILITY . . . is the key component of the new Anacom 150. No bells no whistles, no problems, just consistent high quality output.

This nine wire dot matrix printer features a ballistic type print mechanism guaranteed for three million characters. Low count (16) integrated circuits add to the reliability of the printer.

Microprocessor controlled logic seeking bi-directional head allows the Anacom to print up to speeds of 150 characters per second. 136 columns wide.

Adjustable tractors and variable head gap permit the Anacom to accept fifteen inch wide multi-part forms.

Switch selectable: skip paper perforation, carriage return/line feed and six or eight lines per inch.

Lexan paper shield and enclosure sound proofing add to the overall quality of the printer.

The Anacom 150 is definitely the best value in todays extremely competitive world of micro-printers.

If you are in the market for a "Quality Engineered" dot matrix printer, please consider the Anacom 150 before purchasing a less reliable machine.

Available either RS-232 serial 9600 baud. PRA-150S or Centronic parallel PRA-150P. Field exchange. UPS shipping weight 40 pounds.

Introducing the

ANACOM 150

DOT MATRIX PRINTER

Mfg. suggested list $1350

California Digital Introductory Price

$995



IBM 3101 DISPLAY TERMINAL

The new 3101 display terminal is the IBM entry into the plug compatable micro computer industry.

This modularly constructed CRT terminal has been engineered with the user in mind. The video display modules swivels and tilts to provide the operator with a comfortable viewing posture.

Twelve inch P-39 green phosphor screen boasts a crisp 7 by 14 character matrix.

Standard 80 by 24 line screen format with a 25th line to display machine status and aid in the diagnostics in the event of a system malfunction.

87 key Selectric style keyboard arrangement along with numeric entry pad. Eight user definable function keys.

The 3101 video terminal is RS232 compatable and displays all 128 ASCII characters including control codes.

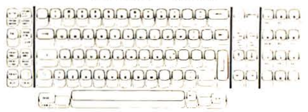
Accessible customer setup switches aid in choosing such options as line speed, parity scroll, and reverse video.

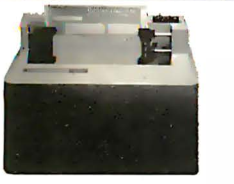
But most of all, built into every 3101 terminal is the quality that you have learned to expect from the IBM Corporation. VDT-3101

IBM direct price $1295

CALIFORNIA DIGITAL discount price

$1195 immediate deliver





NEW

from INTEGRAL DATA

460 Paper Tiger

with GRAPHICS **$1150**

The 460 Paper Tiger uses a dot matrix character formation technique in which the placement of the dots overlap both horizontally and vertically to achieve a correspondence quality printing.
The printer's nine-wire print head uses staggered needle rows to create the vertically overlapping dots. The head is driven bi-directionally under microprocessor control by a stepper motor driven mechanism.
"Two K" buffer allows the printer to accept the entire content of a 1,920 character CRT screen. With graphics suggested retail price $1,395 27 lbs. PRG-460G

NEC Spinwriter 5510P/S $2495



The word processing quality Spinwriter prints at speeds upto 55 characters per second. The Model 5510 P/S is supplied with both parallel and RS-232 serial interfacing. Also included is the tractor feed mechanism, along with print thimble and ribbon. PRN-5510PS 70 lbs. Keyboard (KSR) Model 5520 P/S available $2995. PRN-5520 PS 75 lbs.



TEC V-300 Word Processing

Daisy Wheel Printer

$1595

Finally a reasonably priced letter quality printer... Bi-directional printing at 25 characters per second. Full 136 print positions wide. Proportional spacing 1/120" horizontal, 1/48" vertical.
Uses standard Diablo brand interchangable daisy print wheels.
Intel 8085 CPU microprocessor controlled. Interfaces via Centronics parallel connector. Shipping 58 lbs. PRV-300.

TELETYPE® MODEL 43

4320 KEYBOARD MODELS

TTL serial output	AAA	$ 995
RS232 serial	AAK	1050
Friction 80 column	AAE	1100
Friction 80 RS232	AAL	1195
Bell 103 Modem	AAB	1495



TELETYPE



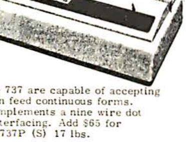
EPSON MX-80 $495

The MX-80 is a 9x9 80 character per second dot matrix printer. Tractor feed mechanism adjusts to accept ten inch wide continuous paper. Requires "Eight bit" Centronics type parallel interfacing. PRE-MX80 17 Lb.

CENTRONICS

730 $595

737 $750



Both the Centronics 730 and the 737 are capable of accepting standard office letterhead or pin feed continuous forms. For higher resolution the 737 implements a nine wire dot matrix print head. Parallel interfacing. Add $65 for RS232. PRC-730P (S). PRC-737P (S) 17 lbs.

HEWLETT PACKARD $2650



HP 85

The Hewlett Packard HP-85 is a complete, low cost portable computer system. This self contained package includes CPU, keyboard, printer, CRT display and cassette tape drive. SYS-HP85 30 lbs.



AMPEX DIALOGUE 80 CRT TERMINAL

$995

New from the Ampex Corporation. The Dialogue 80 features removable keyboard, displayable two pages (four optional) dual program keys, half intensity protected fields and status line. Transmits data either block, line or character mode. Excellent value. VDT-D80 shipping 47 lbs.



ADDS

Applied Digital Data Systems Inc

REGENT 25 $850
80 character by 24 line twelve inch screen. 18 key numeric-entry cluster. Reverse video. Displayable control characters. VDT-R25 ship. 60 lbs.

REGENT 30 $950
Additional features. Special function keys. High resolution graphics. 25th status line. Multi-intensity screen. Superior quality keyboard. VDT-R30

REGENT 40 $1195
Insert/delete line feature. Eleven special graphic symbols. VDT-R40

REGENT 60 $1405
Buffered display. Block mode transmission. Protected fields. VDT-R60



BMC VIDEO MONITOR $259

Green phosphor with 18 MHz bandwidth, composit video input make the BMC KG-12C an ideal monitor for anyone requiring a high resolution 12" display.
High impact plastic enclosure assures that the BMC monitor is a rugged take anywhere instrument. For added protection the unit is equipped with a removable smoked non-glare plexiglas screen. VDM-BMC 18 lbs.



direct connect MODEM

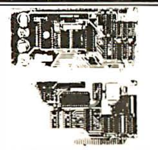
Your Choice $169

Direct connect modems eliminate loss of information due to the carbon compression associated with acoustic modems. Choose either of these two great units.

The Universal Data Systems 103LP is switch selectable between answer and originate modes. Fully Bell 103 compatable. Directly connects to the new modular telephone jack. 100% powered from the telephone line. No need to locate modem in proximity to A.C. power recepticle. MOD-103LP 2 pounds.

Novation "D" Cat connects to most of the new "Bell" modular handsets. Ideal for multiple line office telephones. Requires external A.C. power. MOD-DCAT 2 Lb.

ACCESSORIES FOR THE APPLE COMPUTER

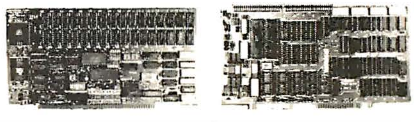


CALIFORNIA COMPUTER SYSTEMS	
Arithmetic Processor 7811 B/C	$319
Asynchronous serial interface 7710	129
Centronics Interface card 7728	95
12K PROM Module 7114	69
Calender/Clock, Bat. back-up 7424	99
Parallel Interface 7720A	99
Programable Timer 7740A	99
Analog/Digital converter 7470A	99
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Apple to Z-80 CPU card	379
D.C. HAYES PRODUCTS	
Micromodem for Apple	319
COMPUTER STOP PRODUCTS	
Double Vision / 80 Column Video	250
INTERACTIVE STRUCTURES	
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MOUNTAIN COMPUTER PRODUCTS	
Intro X-10 system for BSR	$239
Intro X-10 card only	165
16 channel AD/DA 8 bit	319
Apple Clock battery back-up	225
Supertalker SD200	245
ROM Plus with filter	165
ROM Writer/Programmer	149
APPLE BRAND PRODUCTS	
Apple Language card	450
Floppy disk with controller	560
Floppy disk without controller	495
Apple parallel interface	175
SSM MICROCOMPUTER	
Dual serial parallel interface AIO	
SORRENTO VALLEY ASSOCIATES	
8" floppy controller (Pascal)	360

S-100 BOARDS

Assembled • Tested • Burned-in



MEASUREMENT SYSTEMS	
Dynamic memory DMB-6400	$770
Dynamic memory DMB-3200	700
GODBOUT/COMPUPRO	
Dual 8088/8085 16 bit CPU	375
Z-80 CPU 24 bit address 4 MHz	239
Static RAM 32K (Alpha Micro)	575
Spectrum color graphics board	329
Interfacer II I/O board	199
SEATTLE COMPUTER PRODUCTS	
8086 16 bit CPU 2 card set /86 dos	595
CALIFORNIA COMPUTER SYSTEMS	
S-100 Mainframe 2200A	329
Disk controller/2.2 CPM 2422	329
Z-80 CPU 4 MHz DMA 2810A	250
DIGITAL RESEARCH	
32K 2716 EPROM board	99
EPROMS for above 2716 16 req.	13
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A/D board 16 channel 12 bits	
QT COMPUTER SYSTEMS	
Real time clock/calendar	135

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Multiboard "NEW" Daisy wheel port, real time clock, power on jump, program interrupt com'l 3P/3S	$275
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PROM-100 programmer	229
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Versafloppy 3740 controller	375
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Relay opto/control board	145
D. C. HAYES PRODUCTS	
Micromodem S-100 FCC register	375
ARTEC ELECTRONICS	
Wire Wrap proto board WW/100	22
General Purpose proto GP/100	22
CALIFORNIA DIGITAL	
8086 CPU 4K on board static RAM	450

TELETEK SINGLE BOARD COMPUTER FLOPPY DISK CONTROLLER



The FDC-1 features the Z-80 CPU along with the NEC 765 floppy disk controller. The board supports both single or double density 5 1/4 or 8" disk drives. Two serial (45-9600 bd) and two parallel ports add to the flexibility of this single board computer. Other standard features are real time clock, reset jump to monitor, vectored interrupts and potential for controlling a Winchester hard disk drive. With the addition of an external 25 volt power supply the Teletek board becomes capable of programing 2716 EPROMS. LDC-FDC1 **$695**

S-100 Mother Board $35

Quiet Buss™

8803-18

18 slot

IMSAI



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master charge

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Circle 317 on inquiry card.

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DETACH OUR CATALOG FROM THE NOV. BYTE

2114-3L	5257-3L	2708	2716
4096 BIT (1024x4) 300ns LOW POWER STATIC RAM	(TMS 4044) 4096x1 300ns LOW POWER STATIC RAM	450ns 8K EPROM	450ns 5 Volt only 16 K EPROM
8/$32.00 100 + $3.00	8/$50.00 100 pcs. + $4.75	$8.50 each or 8/$54.00	$11.95 each or 10/$90.00

TRS-80/APPLE
MEMORY EXPANSION KITS
4116's RAMS
from Leading Manufacturers
(16Kx1 200/250ns)
100% GUARANTEED — 1,000's SETS SOLD
8 for $29.00
ADD $3.00 FOR PROGRAMMING JUMPERS FOR TRS-80 KEYBOARD
4116's 100 pcs & UP $3.00 each
1000 pcs & UP $2.75 each

MODEM SALE
$129.00

THE STAR MODEM from LIVERMORE



FEATURE
FITS GTE HANDSETS!

2 YEAR WARRANTY

EXCLUSIVE ACOUSTIC CHAMBERS

The exclusive triple seal of Livermore's new flat mounted cups locks the handset into the acoustic chamber yielding superior acoustic isolation and mechanical cushioning. Designed to adapt to most common handsets used throughout the world, the STAR offers the utmost in flexibility and transmission reliability.

Specifications:
- **Data Rate:** 0 to 300 baud
- **Compatibility:** Bell 103 and 113; CCITT
- **Frequency Stability:** ±0.3 percent. Crystal controlled
- **Receiver Sensitivity:** —50 dBm ON, —53 dBm OFF
- **Modulation:** Frequency shift keyed (FSK)
- **Carrier Detect Delay:** 1.2 seconds ON; 120 msec OFF
- **EIA Terminal Interface:** Compatible with RS 232 specifications
- **Teletype Interface:** 20 milliampere current loop
- **Optional Interfaces:** IEEE 488; TTL; TTY 43
- **International (CCITT) frequencies available**
- **Switches:** Originate/Off/Answer; Full Duplex/Test/Half Duplex
- **Indicators:** Transmit Data, Receive Data, Carrier Ready, Test
- **Power:** Supplied by 24 VAC/150 MA UL/CSA listed wall-mount transformer. Input 115 VAC, 2.5 watts. (A 220 VAC, 50 Hz adaptor is available upon request.)
- **Dimensions:** 10" x 4" x 2"
- **Weight:** 1.74 lbs. (3 lbs. shipping weight including AC adaptor.)
- **Warranty:** Two years on parts and labor, excluding the AC adaptor which carries the manufacturer's warranty

Part No.	Description	List Price	SALE PRICE
LIV-STAR	RS232, TTL Modem	$199.00	$129.00
LIV-STAR20M	RS232, 20MA Current Loop	$199.00	$129.00
LIV-STAR-V21	CCITT European Standard	$229.00	$209.00
LIV-IEEE	IEEE 488 Standard	$395.00	$249.00
LIV-IEEE-V21	IEEE 488, CCITT Standard	$465.00	$388.00

CABLES

Part No.	Description	Price
CND-RS2328F	RS232 8 Cond 8 ft.	$19.95
LIV-I21	IEEE to IEEE 2 Meter	$59.95
LIV-I2PET	IEEE to Pet 2 Meter	$59.95

RS232 and "D" SUB-MINIATURE CONNECTORS



P = Plug, Male Type - S = Socket, Female Type - C = Cover, Hood

PART NO.	DESCRIPTION	PRICE 1-9	10-24	25-99
CNO-DE9P	9 PIN MALE	$ 2.10	$ 1.90	$ 1.70
CND-DE9S	9 PIN FEMALE	$ 2.70	$ 2.40	$ 2.10
CND-DE9C	9 PIN COVER	$ 1.50	$ 1.25	$ 1.10
CND-DA15P	15 PIN MALE	$ 2.75	$ 2.45	$ 2.15
CND-DA15S	15 PIN FEMALE	$ 3.95	$ 3.60	$ 3.20
CND-DA15C	15 PIN COVER	$ 1.50	$ 1.30	$ 1.10
CND-D825P	25 PIN MALE	$ 3.50	$ 3.25	$ 3.00
CND-D825S	25 PIN FEMALE	$ 4.60	$ 4.35	$ 4.20
CND-D851212	1 PC. GREY HOOD	$ 1.60	$ 1.45	$ 1.30
CND-P25H	2 PC. GREY HOOD	$ 1.50	$ 1.25	$ 1.10
CND-D851226	2 PC. BLACK HODD	$ 1.90	$ 1.65	$ 1.45
CND-DC37P	37 PIN MALE	$ 5.80	$ 5.10	$ 4.45
CND-DC37S	37 PIN FEMALE	$ 8.70	$ 7.70	$ 6.70
CND-DC37C	37 PIN COVER	$ 1.80	$ 1.55	$ 1.30
CND-DD5DP	50 PIN MALE	$ 8.75	$ 7.75	$ 6.70
CND-DD5DS	50 PIN FEMALE	$11.65	$10.25	$ 8.90
CND-DD5DC	50 PIN COVER	$ 2.00	$ 1.80	$ 1.60
CND-D20418	HARDWARE SET 2 PR.	$ 1.00	$ 0.80	$ 0.70
CND-RS232BF	RS232, DB25P, EIA CLASS 1 CABLE 8 CON. 8 FT.	$19.95	$17.95	$15.95
CND-5730360	CENT. 700 SERIES PRINTER CONNECTOR	$ 9.00	$ 7.50	$ 6.00

GODBOUT SALE

Static S-100 Memory

32K ECONORAM XX

		List Price	Our Price
GBT164A16	16K RAM A&T	$399.00	$329.00
GBT164A24	24K RAM A&T	$539.00	$455.00
GBT164A32	32K RAM A&T	$699.00	$569.00

16K ECONORAM XIV

		List Price	Our Price
GBT143U	Unkit		$279.00
GBT143A	A&T	$349.00	$299.00

SPECTRUM S-100 COLOR GRAPHICS BOARD

		List Price	Our Price
GBT144U	UNKIT		$299.00
GBT144A	A&T	$399.00	$349.00
GBT2D	SUB LOGIC UNIVERSAL GRAPHICS INTERPRETER SOFTWARE		$35.00

8085/8088 CPU BOARDS

Board with 8085 only

		List Price	Our Price
GBT161U	Unkit		$235.00
GBT161A	Assembled & Tested	$325.00	$305.00

BOARD WITH 8085 & 8088

		List Price	Our Price
GBT1612U	Unkit		$295.00
GBT1612A	Assem. & Tested	$425.00	$399.00

I/O BOARDS

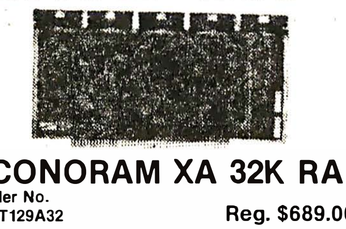
INTERFACER I — 2 SERIAL I/O

		LIST PRICE	OUR PRICE
GBT133U	Unkit		$ 199.00
GBT133A	A&T	$249.00	$219.00

INTERFACER II — 3 PARALLEL 1 SERIAL

		List Price	Our Price
GBT 150U	UNKIT		$199.00
GBT 150A	A&T	$249.00	$219.00

SAVE $239.00



ECONORAM XA 32K RAM

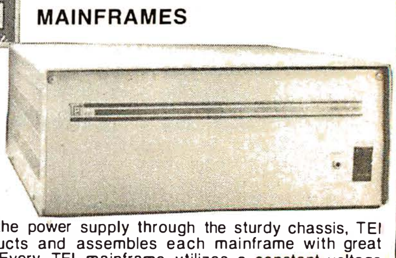
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GBT129A32

Reg. $689.00

Sale Priced
$450.00

- 4MHz with Z80
- 5 MHz with 8085
- Assembled and Tested
- S-100 Compatible
- Fully Static
- 24 Bit Extended Addressing

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From the power supply through the sturdy chassis, TEI constructs and assembles each mainframe with great care. Every TEI mainframe utilizes a constant voltage transformer (CVT) which delivers clean, regulated power at the proper level, reducing the heat in the computer cards. The output voltage on the transformer remains nearly even with the input voltage varying from approximately 85V to 140V. This means the mainframe will never notice voltage variations or even a brownout. It also provides 100 dB noise rejection to protect the computer from voltage spikes and line noise.

S-100 MAINFRAMES		LIST PRICE	OUR PRICE
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TEI-MCS 122	22 Slot Desk	$845.00	$760.00
TEI-RM 12	12 Slot Rackmount	$800.00	$720.00
TEI-RM 22	22 Slot Rackmount	$945.00	$850.00
Shipping Weight:	On 12 Slot Mainframes	35 Lbs.	
	On 22 Slot Mainframes	50 Lbs.	

DUAL 8" DISK CABINETS

TEIDFDO	Desk Cabinet	$ 675.00	$ 599.00
TEIRFDO	Rack Mount	820.00	749.00

Include Money for Shipping on all Mainframes

S-100 GODBOUT MOTHERBOARDS

		LIST PRICE	OUR PRICE
GBT-153U	UNKIT 6 SLOT		$ 89.00
GBT-153A	A&T 6 SLOT	$129.00	$119.00
GBT-154U	UNKIT 12 SLOT		$129.00
GBT-154A	A&T 12 SLOT	$169.00	$149.00
GBT-155U	UNKIT 20 SLOT		$174.00
GBT-155A	A&T 20 SLOT	$214.00	$189.00

CCS-2810 Z80 CPU
2/4 MHZ CPU W/Serial I/O

		List Price	SALE
CCS-2810	A&T	$300.00	$275.00

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*SOCKET and CONNECTOR prices based on GOLD, not exceeding $700 per oz.

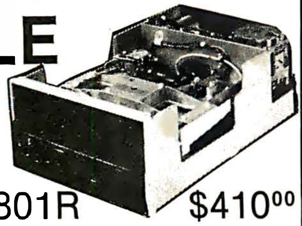
*Sale Prices are for prepaid orders only credit card orders will be charged appropriate freight

DETACH OUR CATALOG FROM THE NOV. BYTE

DISK DRIVES, etc.

DETACH OUR CATALOG FROM THE NOV. BYTE

Shugart SA801R SALE

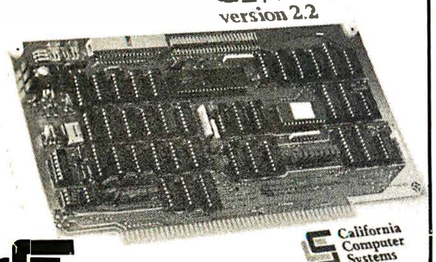


SHU-SA801R $410.00

2 OR MORE $395.00 ea.

Capacity	Single Density	Double Density
Unformatted		
Per Disk	3.2 megabits	6.4 megabits
Per Track	41.7 kilobits	83.4 kilobits
IBM Format		
Per Disk	2.0 megabits	n/a
Per Track	26.6 kilobits	n/a
Transfer Rate	250 kilobits/sec.	500 kilobits/sec.
Latency (average)	83 ms	83 ms
Access Time		
Track to Track	8 ms	8 ms
Average	260 ms	260 ms
Setting Time	8 ms	8 ms
Head Load Time	35 ms	35 ms

CP/M version 2.2



California Computer Systems

California Computer Systems CCS2422A

FLOPPY DISK CONTROLLER WITH CP/M VERSION 2.2

LIST $400.00 SALE $375.00

IEEE S-100 CAMPATABLE SINGLE/DOUBLE DENSITY 5¼"/8" DISK DRIVES SINGLE/DOUBLE HEADED ASSEMBLED & TESTED



Verbatim

Removable magnetic storage media

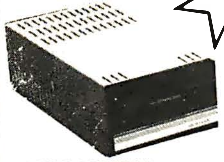
Part No.	Sectoring	Application	Box of 10
VRB-MD 525-01	Soft Sector	TRS-80 Apple	$29.95
VRB-MD 525-10	Hard 10 Sector	North Star	$29.95
VRB-MD 525-16	Hard 16 Sector	Micropolis	$29.95
VRB-MD 577-01	Soft Sector	77 Track Cert	$48.00
VRB-MD 577-16	Hard 16 Sector	77 Track Cert	$48.00
VRB-FD32-1000	Hard Sector	Shugart 801R	$37.00
VRB-FD34-1000	Soft Sector	IBM 3740	$37.00

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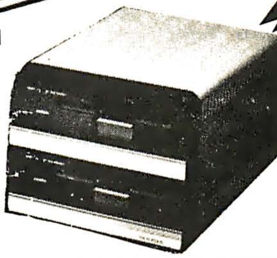
35 TRACK ADD-ON FOR THE TRS-80

LIST $545.00

SALE $279.00



MCP1027M1



MICROPOLIS OVERSTOCK LIST

MODEL	DESCRIPTION	LIST	SALE PRICE
S-100 SUB-SYSTEMS			
MCP-1053-4	1.2 MB 2 HEAD DUAL	$2605.00	$1395.00
MCP-1053-2	630 KB DUAL	$1895.00	$995.00
MCP-1043-2	315 KB SINGLE	$1145.00	$695.00
MCP-1041-2	315 KB SINGLE, NO PS	$1045.00	$639.00
MCP-1042-1	143 KB SINGLE	$795.00	$625.00
MCP-1041-1	143-KB SINGLE, NO PS	$695.00	$595.00

COMPLETE W/S-100 CONTROLLER, CABLES, MANUALS AND MICROPOLIS MDOS AND BASIC

MODEL	DESCRIPTION	LIST	SALE PRICE
ADD-ON DRIVES			
MCP-1033-2	630 KB DUAL	$1395.00	$895.00
MCP-1023-2	315 KB SINGLE	$645.00	495.00
MCP-1021-2	315 KB SINGLE, NO PS	$545.00	$475.00
MCP-1022-1	143 KB SINGLE	$545.00	$375.00
MCP-1021-1	143 KB SINGLE, NO PS	$445.00	$360.00

REQUIRES ACCESSORY ADD-ON CABLES

MODEL	DESCRIPTION	LIST	SALE PRICE
TRS-80® DISK DRIVES			
MCP-1027-1	35 TRACK SINGLE	$545.00	$299.95
MCP-1037-1	35 TRACK DUAL	$1195.00	$695.00
MCP-1027-2	77 TRACK SINGLE	$645.00	$439.00
MCP-1037-2	77 TRACK DUAL	$1395.00	$795.00

ACCESSORIES

		SUPPLIED 35 TRACK	ON 77 TRACK
APP 395M	NEW DOS/80 TRS-80® 35 thru 77 TRACK OPERATING SYSTEM	$149.00	$159.00
PR1-34CEEE-2	Two Drive Data Cable		$29.95
PR1-34CEEE-4	Four Drive Data Cable		$39.95

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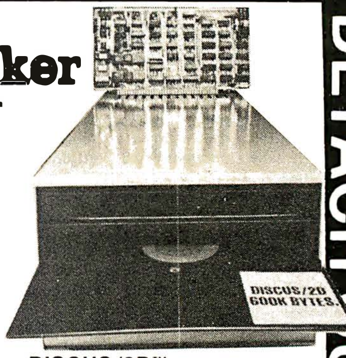
DISCUS M10

10MB 8" HARD DISK DRIVE & S100 CONTROLLER WITH CP/M 2.2

Capacity	
Unformatted	11.7 megabytes
Formatted	10.0 megabytes
Track Capacity	12,000 bytes
Cylinder Capacity	48,000 bytes
Recording Characteristics	
Recording Surfaces	4
Heads per Surface	1
Usable Tracks per Surface	244
Track Density (per inch)	195

	LIST PRICE	SALE PRICE
THTM10S 10MB 8"	$3695.00	$2995.00

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DISCUS/2D™ DOUBLE DENSITY DISK SYSTEM

Why not go all the way to the professional/industrial standard of 600K byte/side disk memory with your S-100 system? The new DISCUS/2D™ full-size, double-density floppy disk system is actually less expensive than many mini-floppy systems.

And Thinker Toys™ hasn't just made full-size, double-density disk memory affordable...we've made it more functional.

Thinker Toys™ has developed BASIC-V™ a virtual disk BASIC that lets you address all 600K bytes (expandable to 1 megabyte) as if were main memory. The data format is soft-sectored and compatible with IBM's new System 34. And DISCUS/2D™ accepts both single-density and double-density disks for complete flexibility in data storage.

And DISCUS/2D™ is even more attractive because it's priced and delivered as a truly complete system. It's complete with all hardware. It's complete with all necessary software. And it's completely assembled, tested and warranted.

Specifications:

- CP/M V2.2 standard
- Plug compatible with Shugart, Remex and Siemens single- or double-sided drives
- Double/single-density capability utilizing MFM and FM data formats
- Western Digital 1791 LSI floppy disk controller chip
- Uses 2K of S-100 address space:
  —1K PROM with built-in disk drive and I/O utility subroutines incorporating memory mapped I/O
  —1K 2114-3L 300 ns access time RAM for disk data offering and general purpose use
- Starting address of memory space is 340:000 (E000 hex) for compatibility with other popular ROM based systems
- Phase-locked data separator and crystal controlled disk data write precompensation capability to insure the highest standards of data integrity in double density mode.
- Compatible with all 2 MHz and 4 MHz systems which conform with the proposed IEEE standard for the S-100 bus
- 1602 UART with crystal-controlled baud-rate generator
- Sixteen switch selectable baud rates from 50 to 19,200 bits/second
- TTY current loop and industry standard RS232C serial interface
- Power-on jump circuitry for automatic bootstrap loading from the disk drive
- Power supply requirements: + 8V @ 1200 ma; + 16V @ 150 ma; —16V @ 70 ma.

	List Price	SALE
THT-02DS Single Drive	$1199.00	$ 998.00
THT-0200 Double Drive	$1994.00	$1649.00
THT-022S Single Drive	$1545.00	$1298.00
THT-0220 Double Drive	$2740.00	$2295.00

DISCUS 1 FULL-SIZE, SINGLE-DENSITY DISK MEMORY SYSTEM

Specifications:

Data Specifications and Formats

- 250,000 byte capacity per standard 8" floppy diskette
- Soft-sectored IBM-compatible format: 77 tracks/26 sectors per track/128 bytes per sector
- Includes Disk/ATE™ disk operating system with integral monitor, assembler and text editor & BASIC-V advanced virtual disk BASIC capable of addressing up to 1 megabyte
- Software customized for SOL and Exidy available
- Patches for CP/M* included
- Optional CP/M* Microsoft BASIC, and FORTRAN available.

	List Price	Our Price
THT-D1S Single Drive	$995.00	$950.00
THT-D1D Dual Drive	$1790.00	$1595.00

DISCUS HD 26 MEGABYTES

	List Price	SALE
THT-M26S Subsystem	$4995.00	$4095.00
THT-M26A Add-on hard disk drive	$4995.00	$3995.00
THT-M26HDC Hard disk controller		$ 695.00

Shipping Weight: THT-M26S&A .... 50 lbs.
Shipping Weight: THT-M26HDC .... 3 lbs.

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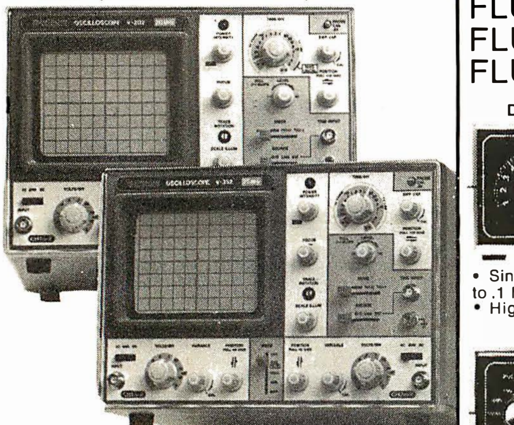
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20MHz DUAL TRACE

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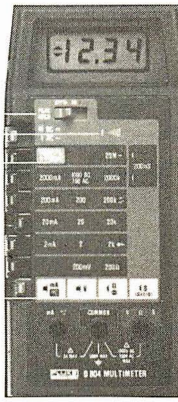
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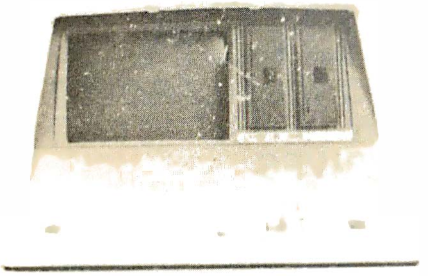
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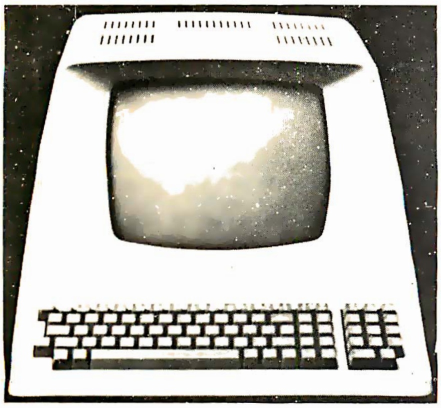
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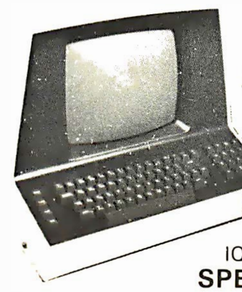


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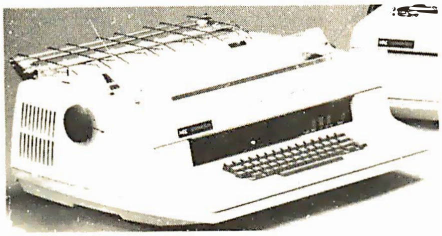


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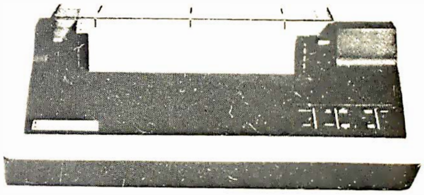
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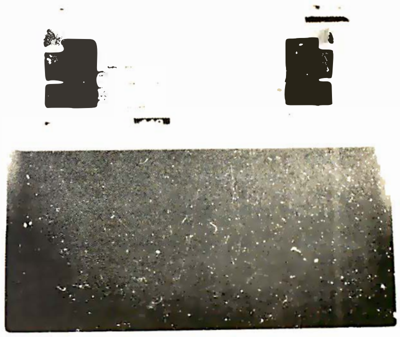
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These notices are free of charge and will be printed one time only on a space available basis. Notices can be accepted from individuals or bona fide computer users clubs only. We can engage in no correspondence on these and your confirmation of placement is appearance in an issue of BYTE.

Please note that it may take three or four months for an ad to appear in the magazine.

FOR SALE: Heath H-11A: 32 K bytes, assembled, serial and parallel interfaces, high-speed paper-tape punch/reader, and extended arithmetic chip. Everything for $1600. Chris Martin, 604 S Remington, Angleton TX 77515, (713) 424-1900 evenings.

FOR SALE: KIM-SI board; $175, 8 K programmable memory; $125, CRT controller board TH3216 (32 by 16); $175. All working, Canadian funds, postage paid in Canada. Will sell to first arrived. Denis Beauregard, 2425 rue-Saint-Antoine, Lachine Quebec, H8S 1V9 Canada.

FOR SALE: SwTPC 6800 with 36 K programmable memory, MF-68 dual minifloppy, PR-40 printer, four parallel and one serial I/O ports. Price negotiable. Ken Staton, POB 10490, Stanford CA 94305, (415) 329-9888.

FOR SALE: Three S-100 8 K static memory boards. They have been in use for over one year without a memory error. Two are Godbout and one is a Processor Tech 8KRA. $125 each or $325 for all three. Jerry Bass, 2326 Platt Dr, Martinez CA 94553, (415) 445-2435.

FOR TRADE: Diablo Hytype I multistrike ribbons (recycled, 37 ea) and new 8-inch floppy disks. Will trade one for one for 5-inch floppy disks. Prefer BASF, DYSAN, or Scotch (no Verbatim). Paul Holliday, 4807 Arlene St, San Diego CA 92117.

FOR SALE: Polymorphic Systems 8813. An S-100, 8080A-based system with keyboard, 9-inch monitor, and dual single-sided drives. Confidence package and Wordmaster text editor included. John D Flynn, POB 563, East Longmeadow MA 01028, (413) 525-3981.

FOR SALE: BPI Business General Ledger Package for Commodore PET. Original, complete with manual and instruction booklet. Robert O Williams, 9949 Hawley Rd, El Cajon CA 92021, (714) 561-4397.

FOR SALE: Two WHA-11-16 16 K by 16-bit memory boards for H-11A or LSI-11. Perfect working condition; making room for disk controller. $350 each. G W Schreyer, 412 N Maria, Redondo Beach CA 90277, (213) 376-9348.

FOR SALE: BYTE #1 thru December 1978. Also, extra copy of #1. PerSci 1070 disk controller and INFO 2000 S-100 adapter card. Best offers. Scott Crumpton, 233 Space Sciences Research Bldg, University of Florida, Gainesville FL 32611.

FOR SALE: Anderson Jacobson AJ 841 I/O printer-terminal. IBM Selectric mechanism. 130 ch/line. New. Plus, Apple parallel-printer interface card. $750. Virginia Stern, 215 E 11 St, New York NY 10003, (212) 477-6634.

WANTED: I am interested in contacting computerists who are doing advanced forecasting on both stock and commodity markets. I retired early and have done very well in speculation through system approach. Ted Broder, POB 407, Flushing NY 11363.

FOR SALE: Hazeltine 1500 terminal. Brand new and unused. Unopened in original carton. $1000 plus shipping. Bill Leeson, 1546 Becklow Ave, Baltimore MD 21220, (301) 574-4797 evenings, (301) 628-4173 days.

FOR SALE: High-speed paper-tape punch. 120 character/second Tally Model P-120A. Includes manual and Whiteford Laboratory Model P1-12A paper-tape winder. $150 for everything. Richard A Libby, 505 Cascade, Richland WA 99352, (509) 946-7341.

FOR SALE: A reliable S-100 computer in a solid oak cabinet. Partial component list of the computer is: Z80 processor (2 MHz), 52 K programmable memory, 8 K erasable-programmable read-only memory, PerSci floppy disk and controller, cassette and PPT I/O, video display, Memory Map Video, Dazzler, 40-column printer, and much more. Extensive software library and documentation included. All for $4200. Write for detailed description. Robert Alkire, 220 E Hellman Ave, Monterey Park CA 91754.

FOR SALE: *Dr. Dobb's Reference Journal*, Vol I, $10. *Basic Computer Games* by Dave Ahl, $6. *Basic Software Library*, R W Brown, Vol I, $15. Scelbi's three volumes: *8080 Editor*, *Assembler*, and *Monitor* with hexadecimal and octal listings and full discussion of programs and their use, $15. Add $1 shipping for each book or take all for $45 postpaid. R Mendelson, 27 Somerset Pl, Murray Hill NJ 07974.

FOR SALE: Centronics 101A 165 cps printer. $400. Parallel interface. Logic board #2 needs repair or replacement. Bill Webb, 180 Winard Ave, Sellersville PA 18960, (215) 257-1161.

FOR SALE: 32 K Exidy Sorcerer computer; $685. SD VR8024 video board; $295. S-100 mainframe, 28 A power supply; $245. SSM VB1B video board; $100. Hank, (714) 245-5054 weekends or evenings after 9 PM.

FOR SALE: Rockwell AIM-65: 4 K programmable memory, BASIC and Assembler read-only memories. Power supply and case. One-year-old; $550. Greg Crandall, (213) 991-7871.

FOR SALE: IMSAI 8080A mainframe, fully loaded with North Star Z80 processor and MDS single-density minifloppy. 44 K of programmable memory. Cromemco TV-Dazzler color graphics. Processor Tech VDM-1 video board and 3P+S I/O board. All documentation and over thirty disks of software. Working well for over three years. Best offer over $2500 takes it. Will not unbundle. Tom Gantner, 233 Woodbourne Dr, St Louis MO 63105.

FOR SALE: Compucolor II: Model 5 (32 K programmable memory), 117-key keyboard, two disk drives, Soundware audio, game paddles, programming manual, maintenance manual, and more than $500 in software. Many games and utilities. Everything in excellent condition. Pete Pacione, 2952 N Meade, Chicago IL 60634, (312) 889-2674.

NEEDED: I want to know Loglan. I want learning aids, Loglan pen pals, or address of the Loglan Institute. Bob Peterson, Apt 1203, 525 E Semoran Blvd, Fern Park FL 32730.

FOR SALE: Jade Big Z Z80A processor for S-100 bus. Fully assembled; will sell for $110. Doug Kelley, 3312 Mae Dr, Warren OH 44481, (216) 824-3113.

FOR SALE: Printer: 165 cps, excellent condition, variable character size, double-width characters, graphics can be added, same mechanism as the IDS printers; $399. S Levine, 1802 Melville St, Ocean NJ 07712, (201) 531-8305 after 6 PM.

WANTED: 6502 macro cross assembler program that runs on 6800 or 6809 machines. Must have good documentation. J L Peterson, 7150 N Terra Vista #704, Peoria IL 61614.

FOR SALE: IBM Selectric II (Micro Computer Devices, Selecterm, system 9710) interfaced for the SOL-20. This Selectric is loaded with all the options. It has tractor feed, dual pitch, ½ backspace, self-correction, and software for a North Star drive. Best offer. Joe Lancaster, 1931 Cedar Ridge Dr #18, Stockton CA 95207, (209) 957-7018.

FOR SALE: Intersil IM-6101 programmable interface element. Compatible with the IM-6100 microcomputer, the PIE provides control signals to peripheral devices for reading or writing on the DX bus by activating the write and read control lines with input/output transfer instructions. Excellent like-new condition. Asking $1500. Glenn Cardinal, (914) 471-9500.

FOR SALE OR TRADE: IMSAI single-board 8048 EROM computer (kit) for $395, cost $499; IMSAI 3 A, 5 V power supply for 8048 single-board computer (never used) for $75, cost $99; IMSAI programmable memory (kit form) for $110, cost $149; or will trade for a video terminal. George Kimble, 203 Eleventh St, Genoa OH 43430, (419) 855-7743 days, (419) 855-4082 evenings.

WANTED: Would like to exchange TRS-80 newsletters with other user groups. I want to exchange the data on disks so I will not need to rekey info. If you know of a group that does newsletters exchange on disk, please let me have their mailing address so I can contact them. Also, give them my address so they can contact me. S80 userNEWSLETTER, POB 28355, Columbus OH 43228.

FOR SALE: Apple II+ (48 K), DOS 3.3, disk with controller, all manuals, Sanyo B & G 12-inch monitor, Videx 80-column board, Hayes micromodem, Qume 5/45 printer, serial I/F card, RF modulator, Easy Writer professional word processing system, Apple Dow Jones Evaluator, Data Capture software. All purchased new on 11/7/80. $6000 or best offer. Whitley Strieber, 300 E 75th St, New York NY 10021, (212) 744-5603.

FOR SALE: HP-67 calculator with standard pack, math pack, manuals, soft leather and plastic cases, and security cradle. All in excellent condition. Best offer. Mark Bellon, 20 Elliot Ave, Centereach NY 11720, (516) 585-5530.

FOR SALE: Commodore PET with 24 K bytes of memory, library of purchased programs, and vinyl cover. $595. Richard Wiesenthal, 145 Central Park W, New York NY 10023, (212) 874-0190.

FOR SALE: Used Texas Instruments Silent 700 portable terminal, Model 745. Purchase price last year was $1600. Available now for $900. A G Fromuth, (603) 625-2932.

FOR SALE OR TRADE: Digital Group Z80 computer (26 K), dual Phi-Decks, Printer B, extra I/O board, lots of software (including Manuscriptor by MicroWorks and Sargon); $1500 or will trade for Apple. Mark Weber, 6515 Wydown, Box 3812, Clayton MO 63105, (314) 863-7026.

FOR SALE: TRS-80: 16 K, Level II with numeric keypad. $550. Heath H-14 printer, 110 thru 9600 bps. Adjustable pin feed. TRS-232 interface for connection to TRS-80 without expansion interface. Both for $550. Tony Greaves, 1370 Niagara Falls Blvd, Tonawanda NY 14150, (716) 838-4957.

FOR SALE: TEL-IT message and inventory computer system. Z80-based terminal with 16-character readout (no CRT). Built-in R/W tape, real-time clock. Will interface to printer. Cost $900; asking $500. Bob Loveless, (714) 689-7800.

FOR SALE: IBM 1980 Buffered Terminal (Model 9) and IBM 7441 Control Unit. Used less than one year by credit company. In perfect working order; terminal has Selectric-type ball and could be converted into printer. Has transmit and receive abilities compatible with Bell Systems. $600 plus shipping. Doug Arnold, Rte #1, Box 278, Hanceville AL 35077, (205) 734-0390 work.

FOR SALE OR SWAP: TI-59, reconditioned and fully operational with Master Library Module. No case or manuals. Will sell for $100 or swap for functional PC-100C printer. Robin Haynes, 352A Washington Rd, West Point NY 10996.

FOR SALE: Brand-new Heath H-8 microcomputer with 4 K memory board, serial/cassette interface, BASIC tape, all assembly and operating manuals. Fully assembled and tested. Total value $614 (assembled) or $489 (kit); you get them assembled for only $275, and I pay shipping. Robert James, 12010 Cabana Ln, Austin TX 78759, (512) 837-4749.

FOR SALE: Intel System 80/10 computer with 19-inch chassis, SBC-635 power supply, fans, four-slot card cage, SBC-80/10 (single-board computer), SBC-016 (16 K programmable memory), SBC-416 (16 K programmable read-only memory), SBC-108 (8 K programmable memory, 4 K programmable read-only memory, six parallel, one serial ports). Also, have extra four-slot card cage with SBC-416, SBC-104 (like 108 but 4 K programmable memory), MCS-80 (SBC card unpopulated). Twenty-six 2708 erasable-programmable read-only memories included. Will sell for about 25% of list price or swap for S-100 bus system. John Gill, Rte 5, Box 370, Blountville TN 37617, (615) 323-2453.

BOMB

BYTE's Ongoing Monitor Box

Article #	Page	Article	Author(s)
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5	96	Infinite BASIC and Infinite Business	Mitchell
6	106	A Pascal Library Unit for the Micromodem II	Woteki
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16	326	A Heating and Cooling Management System	Hall
17	332	Modifying the SwTPC Computer	Weaver

November BOMB Results

Steve Ciarcia found the mark with "Home In on the Range: An Ultrasonic Ranging System" (page 32), which came in first in the voting. Steve receives the $100 first-place prize.

Second place was won by one of the articles on the issue theme of high-resolution graphics, "Micrograph, Part 1: Developing an Instruction Set for a Raster-Scan Display," by E Grady Booch (page 64). He gets the $50 second-place prize.

Graphics-theme articles also captured the next two positions: "A Simplified Theory of Video Graphics, Part 1" by Allen Watson III (page 180) placed third, and "The Future of Computer Graphics" by Bruce Eric Brown and Stephen Levine (page 22) took fourth.

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BYTE'S BOMB is your direct line to the editor's desk. Each month, the two top-rated authors receive bonuses based on your votes. To cast your vote, first look at the list of this month's articles and corresponding article numbers (located in the unclassified ads section on the page preceding the Reader Service list), then rate each article as **Excellent, Good, Fair,** or **Poor** by circling the appropriate number in each column below. Your feedback helps to produce the best possible magazine each month.

Article No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Excellent	801	805	809	813	817	821	825	829	833	837	841	845	849	853	857	861	865	869	873	877
Good	802	806	810	814	818	822	826	830	834	838	842	846	850	854	858	862	866	870	874	878
Fair	803	807	811	815	819	823	827	831	835	839	843	847	851	855	859	863	867	871	875	879
Poor	804	808	812	816	820	824	828	832	836	840	844	848	852	856	860	864	868	872	876	880

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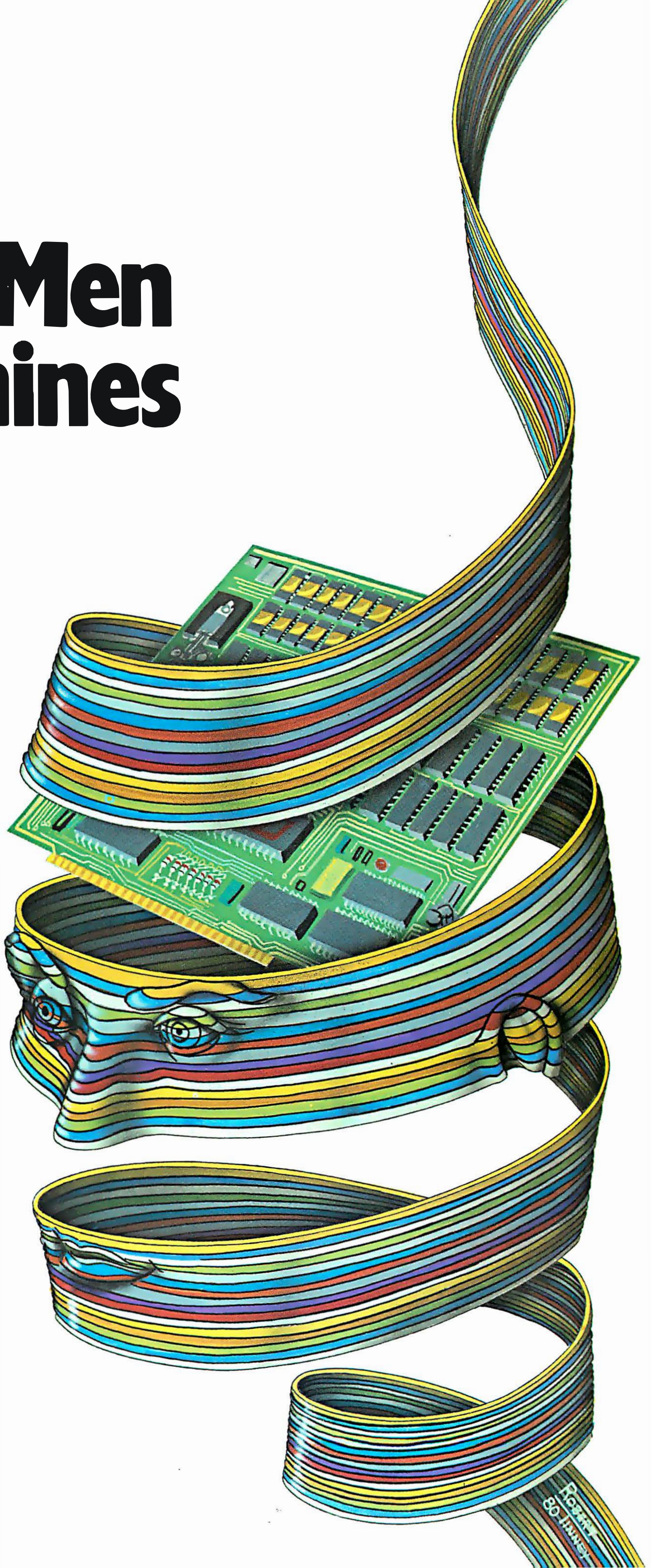
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For more information and the name of the dealer nearest you call 1-800-321-6850.

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